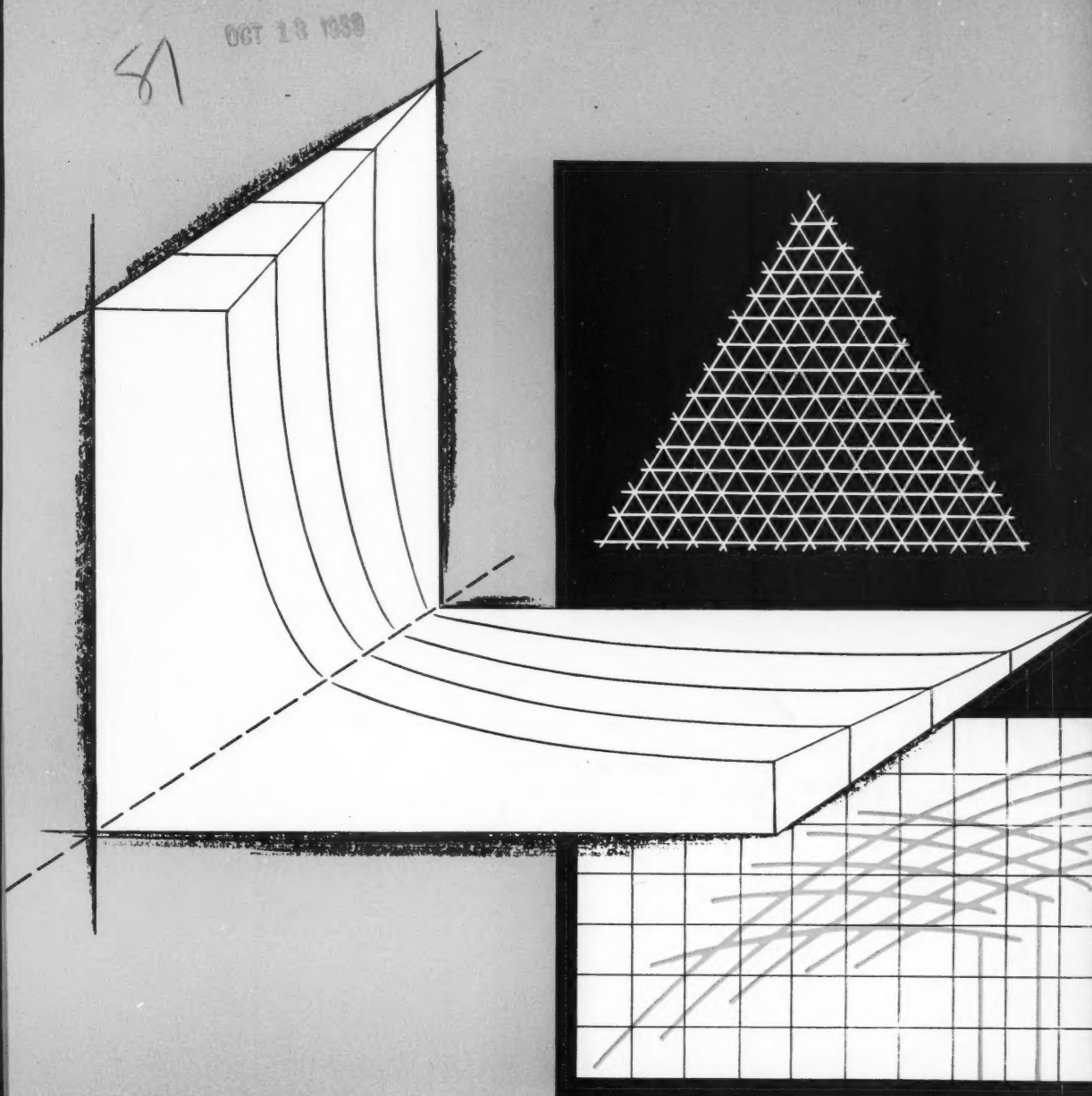


Design Engineering

FIVE DOLLARS A YEAR

51
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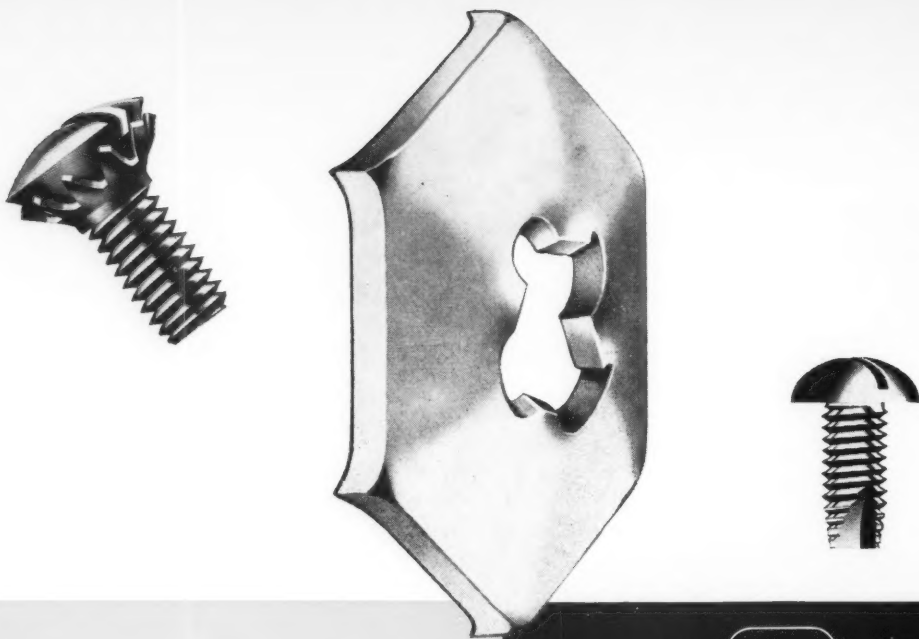
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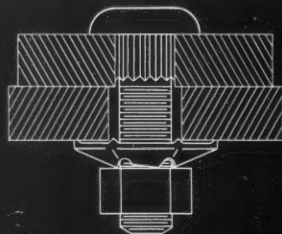
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HOW TO SELECT COST-SAVING

fasteners for
heavy duty
applications



A TYPICAL EXAMPLE: How to Fasten Securely to Avoid Shifting

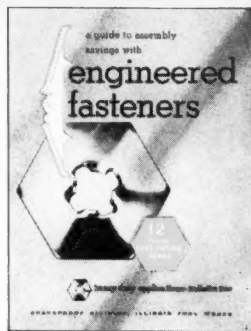
Where considerable tension in the fastening is needed to keep the parts from shifting, the Shakeproof®-developed Pyramidal Lock Washer* should be used. This washer spans large clearance holes — provides tension needed to keep parts securely fastened and in alignment.

*U.S. Pat. No. 2,794,476

For want of the right fastener, man-hours and money are often needlessly lost! It's vital to economical assembly line production to specify fasteners for each application that will do a fast and effective job *every* time. Fasteners engineered by Shakeproof assure maximum locking, reduce handling, and provide many additional functions that save assembly time, reduce production costs and improve your product's quality.

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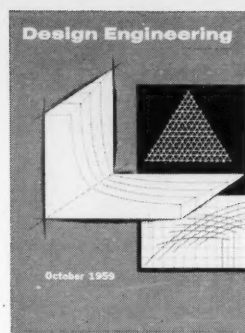
Shows typical examples of money-saving fasteners developed by Shakeproof engineers for heavy metal applications. Offers testing samples. Write for your free copy today!



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Design Engineering

Vol. 5

OCTOBER 1959

No. 10

This month's cover

A carpets and lattices subject by artist Jim Rowland. It points up the original thinking on this matter by Bill Sheppard, who has produced several three and four-dimensional graphs in his article. As a visiting engineer remarked: "Graphs are the hand tools of the engineer."

★ ★ ★

Design Engineering

MEMBER

CCAB

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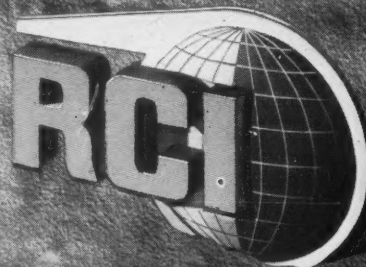
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	FOUNDREZ 7600, 7601, 7605	LIQUID AMINO CORE BINDING RESINS	RAPID COLLAPSIBILITY FAST BAKE — LESS SMOKING
	CO-RELEES 7300	LIQUID SAND CONDITIONER	EXCELLENT SAND WORKABILITY
	coRCIment 7990, 7991, 7992, 7993	LIQUID OLEORESINOUS CORE BINDERS	BROAD BAKING RANGE
	FOUNDREZ 7150, 7151	LIQUID PHENOLIC RESINS FOR SHELL COREMAKING	UNUSUAL STABILITY
	FOUNDREZ 7500, 7504, 7506, 7555	POWDERED PHENOLIC RESINS FOR SHELL MOLDING	SELF-ACTIVATION
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	COROVIT 7201, 7204	POWDERED ACCELERATORS FOR COROVIT OILS	NON-TOXICITY
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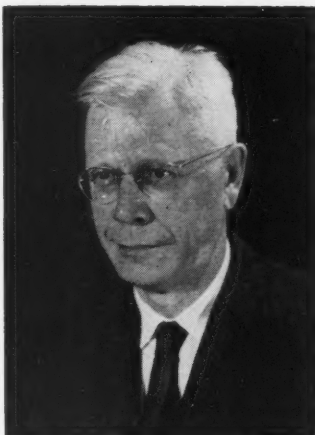
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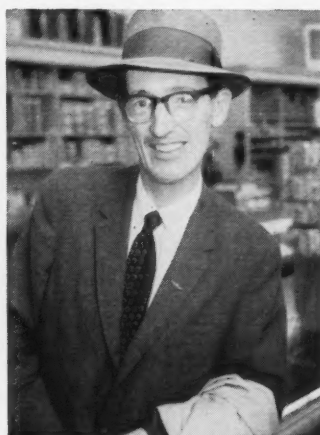
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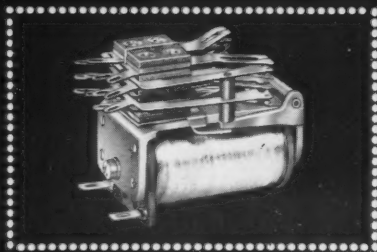
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Dr. John Shotwell is a consulting engineer with a very broad background. A registered professional engineer in Ontario and New York, he is a member of the Engineering Institute of Canada. He graduated from McGill with a B.Sc., later took his M.Sc. from the same university. From Columbia a Ph.D. Shotwell has been in consulting practice since 1931. He has prepared extensive technical-economic feasibility studies and preliminary engineering designs for the proposed development of 2,000 square miles in Labrador. At the Greenland Air Bases, he was Chief, Construction Management Engineering. In World War II, he was consultant in the construction of several large chemical, rubber and munitions plants. On active service with the RCE, he was seconded to the U.S. Army (he is a Colonel, C.E., USAR). This duty involved reviewing of engineer activities in Korea and Arctic operations. He was also responsible for s'aff planning and construction supervision of large engineering projects in Australia. The port reconstruction, gas, transportation and water requirements for the first 120 days of the Western Moroccan invasion came under his jurisdiction. Author Shotwell is chairman of the newly organized Power Section, Toronto Branch, Engineering Institute of Canada. This is the first power section of the E.I.C. When we did manage to pin him down for a minute in his busy schedule, Shotwell told us that his hobbies are horseback riding and swimming.



A frequent contributor to DE, W. H. Sheppard has spent most of his career in the aircraft industry. He attended Woolwich Polytechnic, and graduated from King's College, London University with a B.Sc. in electrical engineering, including mechanical subjects. He next spent seven years with the British Air Ministry and Ministry of Aircraft Production on all phases of inspection. Then came a seven-year period of teaching in various technical institutions. Still seeking variety, Sheppard joined the Bristol Airplane Co. and following his arrival in Canada spent 2½ years with Avro. Finally, to the West Coast for a year with Boeing. Interspersed with all this are Sheppard's travels. When he was in Europe, he found time to fly to Spain and explore the Pyrenees. On his way back, it was only natural to deviate by way of some of the well-known watering places in France. Sheppard tells us that he later flew to Amsterdam, Iceland, La Paz, Seattle over the Arctic route. While in this last spot, he went to Alaska, California and the Coulee Dam. Sheppard's hobbies are experimenting with kite photography and radio-controlled model aero photography. He says he is now actively engaged in mathematical research on vibrations and electrical oscillations. His particular hobby is writing technical articles on the basis of his own investigations. But we also know that Sheppard is an inveterate walker and still rides the bicycle his father gave him on his graduation over 20 years ago.



213,149,873
cycles



Test proves reliability of P&B's LS telephone type relay

These 16 LS relays, wired into a self-cycling chain, each operated 213,149,873 times before the test was discontinued. This test was made for a nationally prominent manufacturer and the certified results are available upon request.

Here is proof of the inherent reliability of P&B telephone type relays... and of the kind of performance you can expect when you specify them. LS relays are available with up to 20 springs (10 per stack) and are adaptable for printed circuit mounting.

Whenever multiple switching of loads up to 4 amperes is required, the LS can usually meet space, weight and—importantly—price considerations. Get full information today by calling or writing Zeke R. Smith, vice president, Engineering, or contact your nearest P&B representative.

LS ENGINEERING DATA

GENERAL:

Breakdown Voltage: 1,000 volts rms 60 cy. min. between all elements.

Ambient Temperature: -55° to $+85^{\circ}$ C.

Weight: 3 to 4 oz.

Dimensions: $1\frac{1}{2}$ " W. x $2\frac{3}{4}$ " L. x $1\frac{1}{2}$ " H. (4 Form C)

Enclosures: Sealed or dust cover (W can)
Sealed or dust cover, up to 6 Form C,
single contacts (D can)

Mountings: Four #6-32 tapped holes $\frac{3}{4}$ " x $\frac{1}{8}$ " o.c. Other mountings available.

CONTACTS:

Arrangements: 20 springs (10 per stack) max.
Material: $\frac{1}{16}$ " dia. twin palladium. Other materials available for specific applications.

Load: 4 amps @ 115 volts 60 cy. resistive.

COIL:

Resistance: 55,000 ohms max.

Power: 65 mw DC per movable standard (50 mw possible); 3.5 watts max. at 25° C.

Voltage: Up to 200 volts DC.

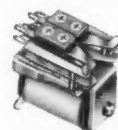
TERMINALS:

Contacts: Three #18 AWG wires.

Coil: Three #20 AWG wires.

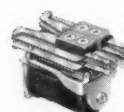
Available with octal plug, taper tabs or printed circuit pins.

**P&B STANDARD RELAYS ARE AVAILABLE AT
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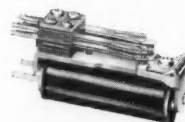
TS RELAY

Short coil relay is available in AC and DC versions. Long life construction. Can be supplied (DC) with up to 20 springs (10 per stack).



GS RELAY

Excellent sensitivity: 50 mv per movable arm minimum (DC). For applications requiring many switching elements in small space.



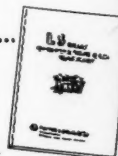
BS RELAY

Long coil provides high sensitivity (25 mw per movable arm) and room for slugs for pull-in delays (150 milliseconds max.) or drop-out delays (600 millisecond max.).

FREE

LS DETERMINATION DATA

Send today for booklet containing certified results of recent test described above. Data includes test circuit, interim and final measurements.



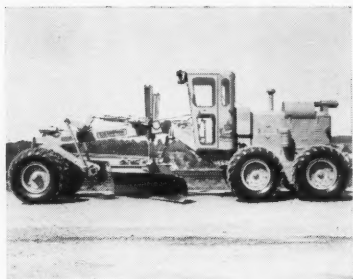
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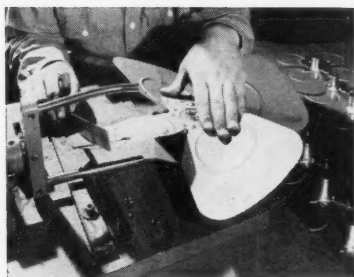
A news roundup of items of engineering and design interest from the world over

Canadian grader designed for Canadian conditions



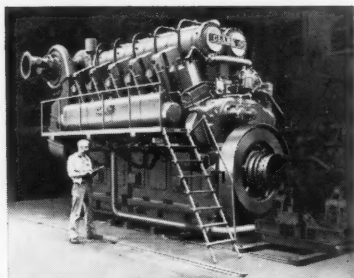
Here is another machine designed and manufactured in Canada. It's a heavy-duty motor grader. Powered by a 160-hp turbo-charged Cummins NT-4 Diesel, it has six speeds in forward and reverse gears, and can whip along at 25 mph. A circle-turn mechanism lets the blade turn through 360 deg with a full load of material. And the operator can position the blade up to 90 deg on either side of the grader for high bank sloping or level grading. Both of these features are patented. The man in the cab isn't forgotten, we're glad to say. He gets the benefit of power-assisted steering and vacuum boosted hydraulic brakes. The cab is designed for Canadian conditions, is insulated and fitted with a heater. Dominion Road Machinery Co. are the manufacturers.

Fan story cools down production costs



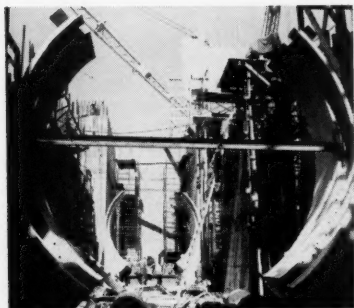
"Waste not, want not," might be the description of this story. A space heater manufacturer in Mercer, Pa. punches a hole in the casing of their heaters, for the placement of a fan. This leaves them with a circular piece of metal from 12-in to 18-in diameter. What to do with it? Well the Reznor Co.'s engineers came up with a good answer. Use it to make the four-bladed propeller fan, instead of buying aluminum blades. The company did just that, and say that the cold rolled steel sheet works every bit as well as the aluminum blades — and the cost is less. The fan is blanked in one operation, and the hub (a screw machine product) is riveted to the blade. Each blade is then electronically balanced. Sounds like a good idea to us.

Aluminum used in giant turbo-engine



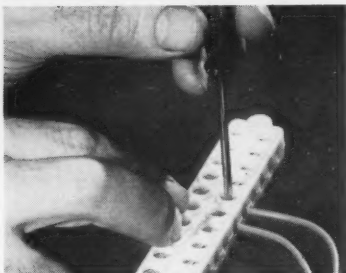
Your credit card wouldn't be much use for this engine. It's a 4,000-bhp job with V-type, turbo-charged, two-cycle gas engine. Unit is designed as a driver for centrifugal compressors in pipeline booster stations, for power generation and pump drive. We believe that the unit actually has a low fuel consumption, as the two-cycle design suggests. Equipped with a jet air started turbocharger, at normal operating conditions, this is completely self-sustaining. Specification includes aluminum main and connecting rod bearings, full pressure lubrication and fully insulated exhaust manifolds. Clark Bros. make the unit, which features a 17-in x 19-in bore and stroke.

Pooled talent for Canada's first atomic power station



Rolphton, sixteen miles upstream from Chalk River, is the site of Canada's first atomic power station. The plant is a co-operative project. Atomic Energy of Canada Ltd., Ontario Hydro and Canadian General Electric Co. are pooling their talent. Known as NPD (Nuclear Power Demonstration), the plant will send 20,000 kw of electricity into Ontario, and is scheduled for completion in 1961. The station is a prototype for larger plants fueled with natural uranium and moderated with heavy water. Canadian Government approval has been given for Atomic Energy to proceed with the design and construction of a 200,000-kw power station known as CANDU (Canadian Deuterium Uranium), at Kincardine, Ontario.

The V-groove cam caused all the trouble



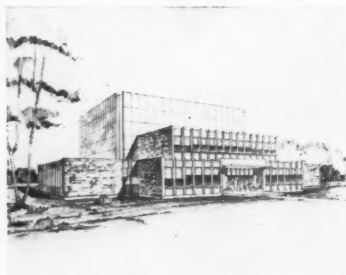
Inventor Ben Doktor's principle for an electrical terminal board captured all the simplicity and economy of motion and effort inherent in good design. But a simple V-groove cam at the core of the device caused a production bottleneck. A mere one quarter inch diameter, the cam has a screwdriver slot at one end and a pivot boss at the other. The peculiar shape of the V-groove, difficulty in tumbling-off tool marks and burrs, coupled with a high cost factor meant conventional machining methods couldn't be used. The answer to the problem was in automatic die-casting. Gries Reproducer Corporation say the technique also chopped the cost of all other production methods by a fifth.

Mobile laboratory for automotive research



What do you think about the smog-producing tendencies of exhaust gas or the air-conditioning of rapidly moving vehicles? Well this bus is very much concerned with these and similar questions. Said to be the only mobile automotive laboratory in existence, Inco presented the fully-equipped vehicle to the University of Michigan for research purposes. The bus was specially designed for on-the-road studies of most aspects of motor vehicle performance. Twenty instruments have been installed in the rolling classroom, which will be used to transport engineering students to their surveys. We hope they'll concentrate on excessive horn blowers, road hogs and back seat drivers.

Another training ground for scientists to open



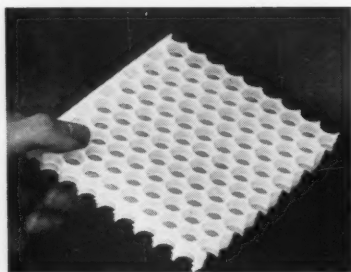
Artist's sketch shows the Cornell University reactor facility. Due to open this fall, the centre will provide training for many potential atomic scientists and engineers. The nuclear unit will include a zero power core for research and training core. The zero power core will be used for studying the basic mechanism whereby a self-sustaining reaction may be utilized. Examination of the interaction between neutrons and their surroundings will also be studied. The instrument will have a flexible design for studying reactors themselves. Professor Trevor R. Cuykendall and Associate Professor David D. Clark of the Cornell Department of Engineering Physics will direct the \$1½ million centre.

Pores in concrete do an insulation job



The tiny non-connecting air cells in this insulating concrete slab are highly uniform in size and shape. At close range you can see that each cell is plastic lined and is a completely sealed dead air space. Density of the lightweight concrete varies from 20 lb per cu ft to 75 lb per cu ft. It can be controlled within tolerances of less than 10%, according to Reflectal Corp. Betocel is composed of Portland cement, sand, water and plastic emulsion. Apparently the mix provides light-weight, strong and well insulated roofs and can be readily sawed and formed with ordinary tools. Mixing is done on the site and material sets overnight.

Louvre throws new light on your ceiling



If you stepped on this louvre — you wouldn't do it any damage. But this isn't likely to happen unless walking on ceilings is your hobby. Material is a non-burning vinyl for lighting applications. Each Circlgrid panel consists of a pair of vacuum formed vinyl sheets hermetically sealed to a centre membrane at every half an inch for structural strength. The 2 x 2 ft. panels have a 50% open area, and each circular opening has small louvres to diffuse reflected light. The result is said to be a highly controlled quality of glare free light. Panels are lightweight, can be sawn easily, fit into any inverted "tee" system of support. J. A. Wilson Lighting and Display Ltd. are the developers and distributors.

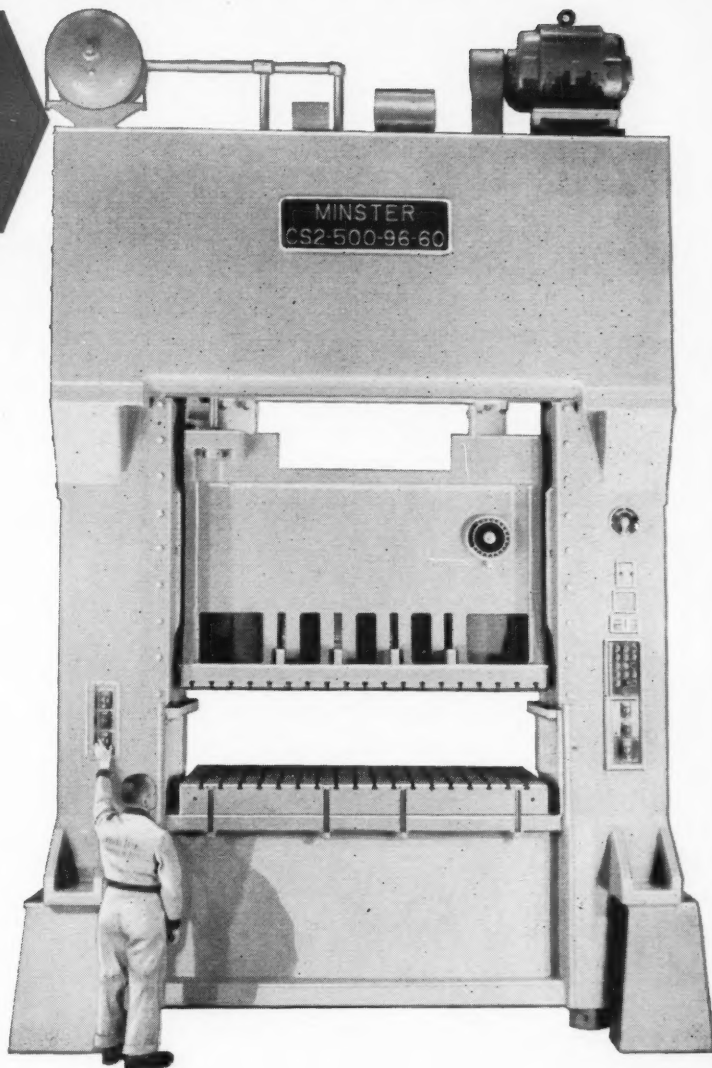
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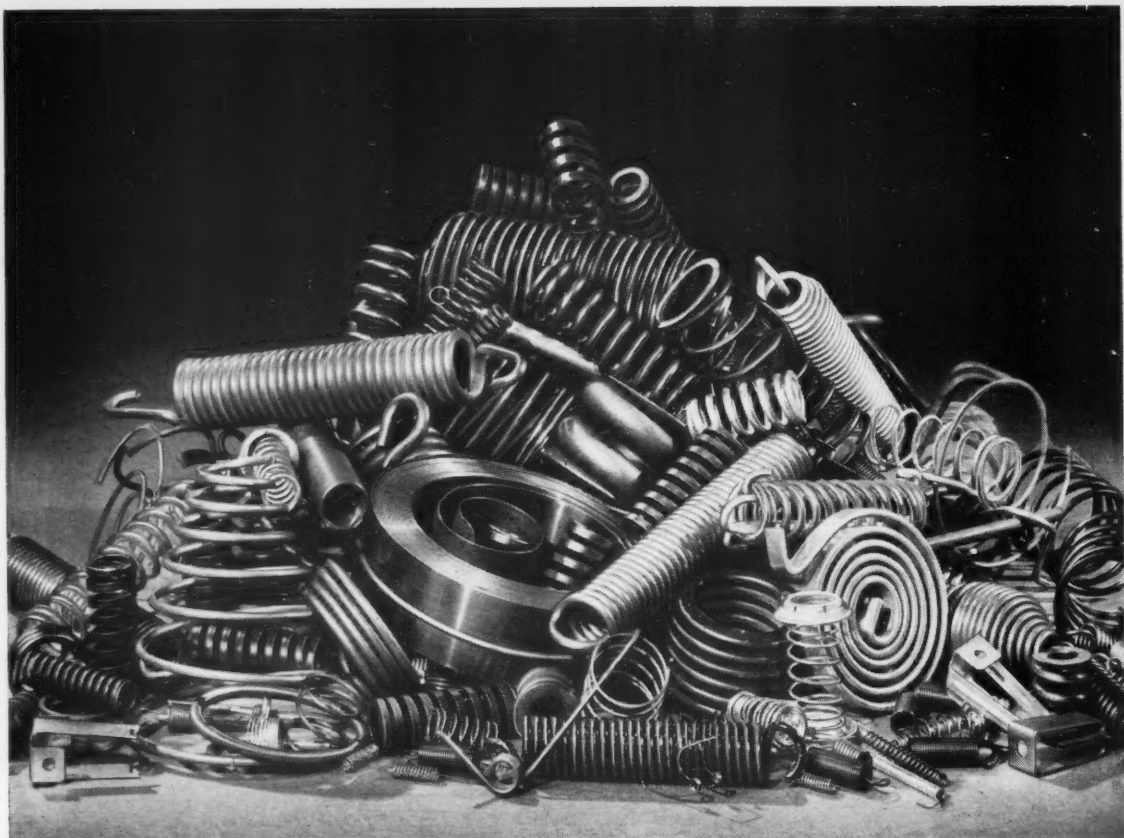
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needle in a haystack?

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If finding the right spring for *your* problem seems like "looking for a needle in a hay-

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Spherical

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**CENTRIFUGALLY CAST
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Big, mirror-smooth, convex rollers . . . hefty inner race flanges . . . centrifugally cast bronze, precision-machined retainers. They're industry's *preferred* bearing features. And they're *all* found in Link-Belt's new spherical roller bearing . . . compactly combined in an exceptionally durable two-piece housing.

These self-aligning roller bearing pillow blocks take misalignment in stride—adjust immediately in any direction while maintaining full load capacity. Two types of shaft mountings facilitate installation . . . adapter mounting for commercial shafting and direct shaft mounting for shafting ground to recommended tolerances. And Link-Belt's rugged steel multi-labyrinth or dacron-contact seals lock out dirt, lock in lubricant.

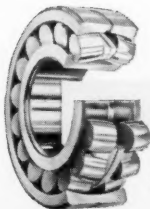
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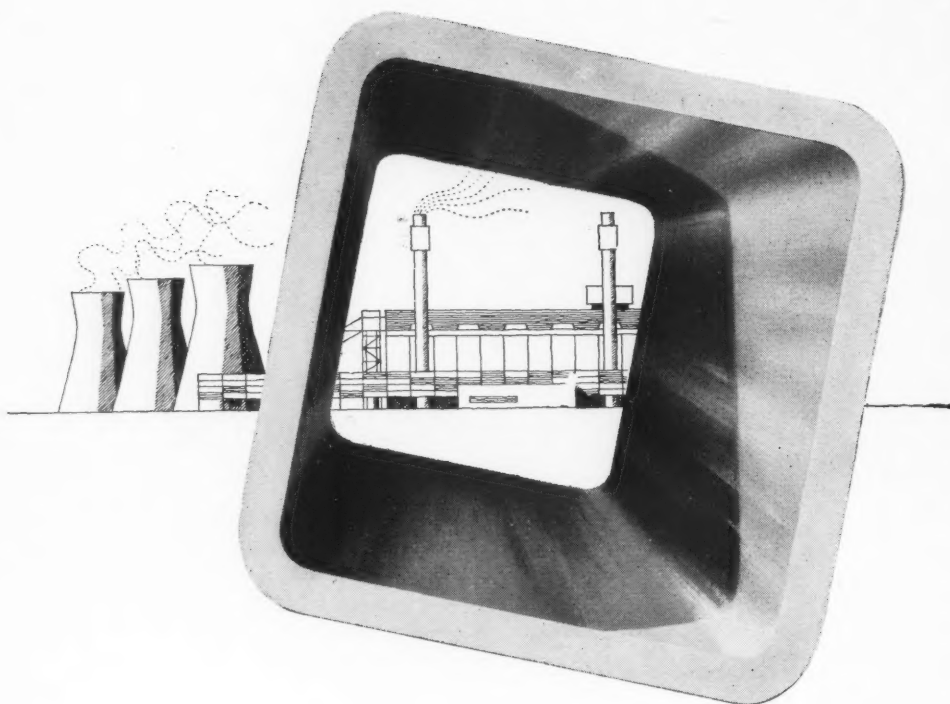
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Series 6800, 6900, 7800, 7900
roller bearing pillow blocks have
spherical roller bearings with in-
ternationally standardized bound-
ary dimensions.



LINK-BELT

SELF-ALIGNING BALL AND ROLLER BEARINGS



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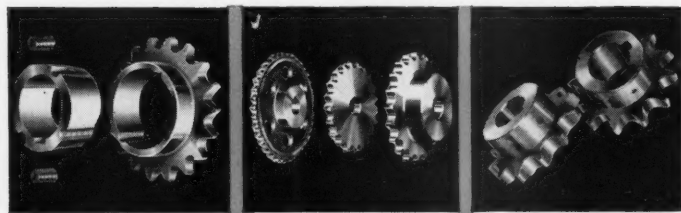
Now...everything you need in roller chain drives from Morse Chain of Canada

...Simcoe, Ontario



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**Morse Taper-Lock
Roller Chain Sprockets**

Taper-Lock construction permits quick installation, easy removal. Bushings are detachable, can be reused. Available from stock for $\frac{3}{8}$ " to 2" pitch chain.

**Morse Plain Bore
Roller Chain Sprockets**

For finishing to your exact specifications. Available in three standard types shown above. $\frac{3}{8}$ " to $2\frac{1}{2}$ " pitch, 9 through 112 teeth, and bores up to $4\frac{1}{2}$ ".

**Morse Finished Bore
Roller Chain Sprockets**

Save money . . . save time. No more reworking charges to pay; no delays for boring. Complete with keyway and setscrew for speedy installation. 216 sizes.

Only Morse offers all four: basic drives (roller chain, silent chain, Hy-Vo®, and "Timing"® Belt); speed reducers; clutches; couplings . . . *plus* the experience and know-how to solve your specific power-transmission problem. Contact your Canadian Morse Distributor. You'll find his name listed in the Classified Directory under "Power Transmission." Or write: Morse Chain of Canada, Ltd.—A Borg-Warner Industry—Simcoe, Ontario. Phone: GARfield 6-4960.



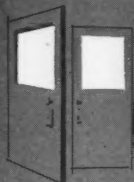
MORSE



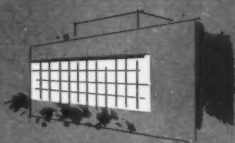
A BORG-
WARNER
INDUSTRY

*Trademark

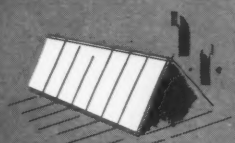
For further information mark No. 140 on Readers' Service Card



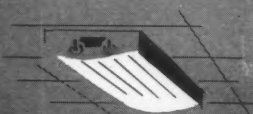
DOOR GLAZING



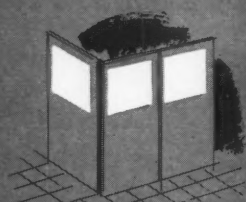
WINDOW GLAZING



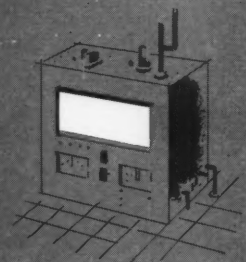
SKYLIGHT GLAZING



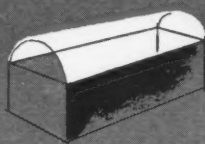
LIGHTING SHIELDS



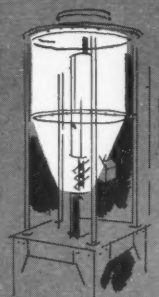
PARTITION GLAZING



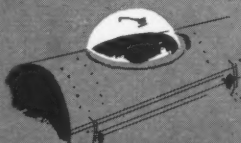
MACHINE WINDOWS



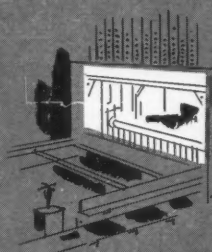
COVERS



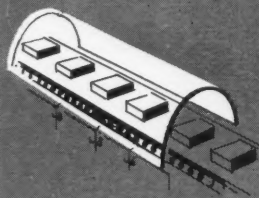
CHUTES



LIDS



GUARDS



HOODS

PROTECT FOOD in PROCESS with **Plexiglas**

Here are a few of the ways PLEXIGLAS® acrylic plastic can help you keep foods free of contamination during processing.

The danger of contamination, resulting in production losses, from broken glass is reduced by PLEXIGLAS glazing for windows, partitions and skylights, and by PLEXIGLAS shields for lighting fixtures.

Protection plus visibility into containers, machines and conveyor systems can be achieved by hoods, lids, covers and windows of transparent PLEXIGLAS.

Strong, lightweight PLEXIGLAS resists breakage, weather and corrosion . . . is available in crystal clear sheets and transparent or translucent colors.



Chemicals for Industry

**ROHM & HAAS
COMPANY
OF CANADA LIMITED**

2 MANSE ROAD, WEST HILL, ONTARIO

PLEXIGLAS is a trademark, Reg. Canadian Pat. Off. and in principal foreign countries.

For further information mark No. 148 on Readers' Service Card

How C.S.F. Steel Castings can help you

CSF steel castings offer you these outstanding advantages

● **STRENGTH** — Steel castings' uniform structural strength assures far better resistance to component stress and metal fatigue.

● **ECONOMY** — The long, efficient life of steel castings means less replacements. Initial cost is usually lower, too.

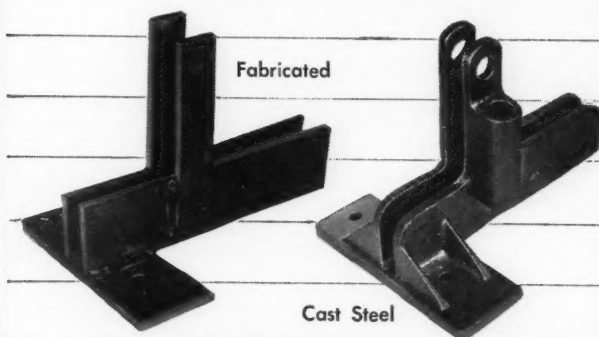
● **LIGHTNESS** — Optimum metal distribution results in ideal weight-strength ratios, low handling and shipping charges.

● **MACHINABILITY** — Castings' machinability and ease of welding makes possible the execution of better designs at lower cost.

● **DIMENSIONAL STABILITY** — This castings advantage makes for high rigidity, minimum deflection, accurate alignment, close tolerance and better fit.

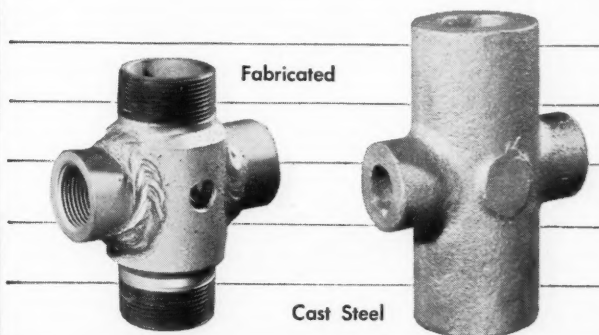
● **SPECIAL PROPERTIES** — When you use CSF steel castings, you can choose from a wide and versatile range of physical and chemical properties.

PLOW HITCH



Cost reduced 48%. No wastage due to warpage.

PRESSURE FITTING



(High Temperature) Cost reduced 35%. Stronger, more dependable.



Consult your CSF Sales Representative for assistance on steel casting design.

CANADIAN STEEL FOUNDRIES LIMITED

5227 Notre Dame St. East, Montreal 4, Que.

Member: A. V. Roe Canada Limited and The Hawker Siddeley Group

For further information mark No. 116 on Readers' Service Card

NEW! HYPALON*

40

● IMPROVED PROCESSABILITY

● IMPROVED PHYSICAL PROPERTIES

HYPALON 40 synthetic rubber is a new type of chlorosulfonated polyethylene polymer with marked improvement in processing and physical properties.

HYPALON 40 has been thoroughly tested in a number of commercial plants producing wire and cable, hose, coated fabrics, extruded and molded goods and industrial rolls. Processability in these trial runs was excellent.

HYPALON 40 bands quickly on the mill and forms a smooth sheet that holds together and releases easily. It dumps cleanly from Banburys. Banbury dump temperatures may be as low as 180° F. Breakdown or peptizers are not needed.

BUILDING WIRE, MINE TRAILING CABLE, HEATER CORD, IGNITION WIRE

HYPALON 40 extrudes fast, smooth and glossy. Good colorability and color stability. Good abrasion, tear and tensile. Doesn't heat-soften. Good aging to 325° F. Electricals adequate for one-shot insulation-and-cover in services to 600v.

(A one-shot HYPALON 20 construction was just approved by Underwriters Laboratories for RHW and RHH building wire, and we see no reason why HYPALON 40 should not pass, too.)

GASOLINE HOSE COVER

Resistant to oil and gasoline. Extrudes fast, smooth and glossy. Colorability and color retention. Good tensile, tear and abrasion. Good weathering.

TEXTILE ROLLS

HYPALON 40 may be the all-purpose roll cover—resistant to all the oils and chemicals used in textile processing.

EXTRUDED SEALS (AUTOMOTIVE, ARCHITECTURAL, INDUSTRIAL)

Good extrudability and compression set

On factory calenders unsupported films as thin as 2 mils were produced. Extrusions, even of lightly loaded stocks, have low die swell, sharply defined profiles, excellent smoothness and gloss.

HYPALON 40 will not support combustion and has neoprene's resistance to oil and solvents. It retains all of HYPALON 20's resistance to ozone, heat aging and oxidizing chemicals. In addition, it has excellent compression set, elongation, tensile and tear strength properties.

Listed are some of the applications for which HYPALON 40 is a candidate, citing in each case the specific advantages of using HYPALON 40:

are important advantages in addition to colorability and resistance to weather, ozone and heat aging.

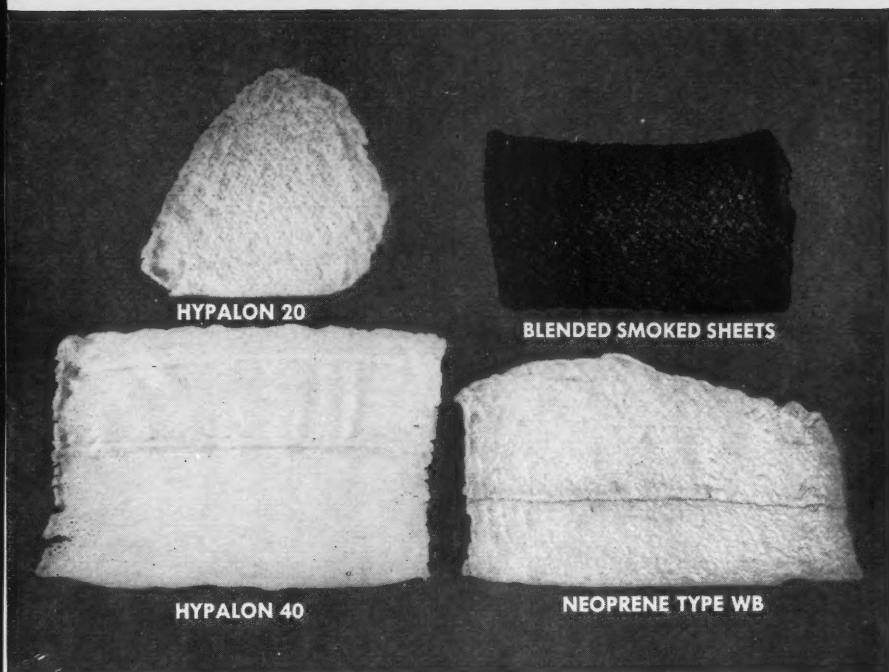
COATED FABRICS

Smooth calendered coatings down to 2 mils thick have been applied on 60-inch factory equipment at normal factory speeds—about 10 yd./min.

AUTOMOTIVE GOODS

HYPALON 40's big asset here is its resistance to the combination: oil, heat and ozone. Colorability, ease of processing and good physicals are added attractions.

For further information mark No. 123 on Readers' Service Card



Compare appearance of HYPALON 40 with other raw polymer samples of equal weight. These samples were milled 3 minutes at 100° F. roll temperature, removed at 0.050 gage.

LOADING	POLYMER	GARVEY DIE EXTRUSIONS
None	HYPALON 40	
None	HYPALON 20	
SRF Black—35 PHR Oil—8 PHR	HYPALON 40	
SRF Black—35 PHR Oil—8 PHR	HYPALON 20	
SRF Black—75 PHR Oil—8 PHR	HYPALON 40	
SRF Black—75 PHR Oil—8 PHR	HYPALON 20	

Compare the low die swell, the sharply defined profiles, and the excellent smoothness of HYPALON 40 extrusions.

Get more detailed information about HYPALON 40 and other Du Pont Elastomers — write for Report 59-2 and your regular copy of "Elastomers Notebook". Du Pont of Canada Limited, 85 Eglinton Avenue East, Toronto 12, Ontario.



SYNTHETIC

RUBBER

NEOPRENE
HYPALON*
VITON*
ADIPRENE*

Better Things for Better Living . . . through Chemistry

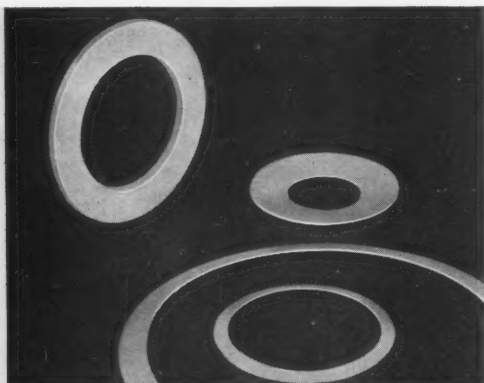
*Registered trademark of E. I. du Pont de Nemours and Co. (Inc.)

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GARLOCK

Teflon* Gaskets

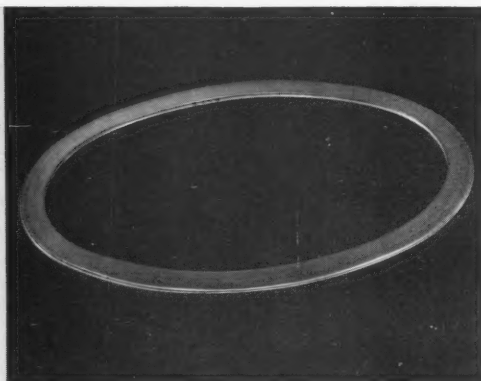
**A DESIGN FOR EVERY JOB INVOLVING
CORROSIVES, EXTREME TEMPERATURES**



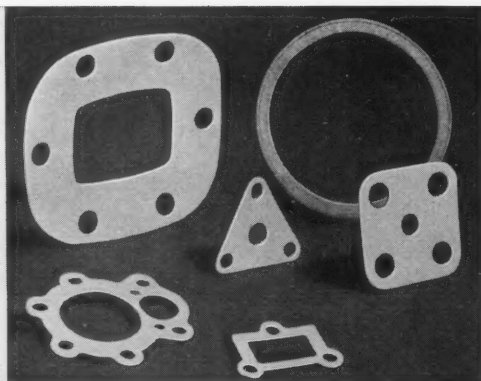
SOLID TEFLON GASKETS remain chemically-inert, tough, non-adhesive at temperatures from -110°F to $+500^{\circ}\text{F}$. Furnished in ring or full face sizes for all standard pipe diameters from 1" to 12". Will withstand pressures up to 300 psi.



TEFLON-JACKETED GASKETS offer the advantage of using Teflon without sacrificing resiliency and deformability. Applied widely to glass-lined process equipment, light metal flanges, glass pipe flanges and fittings. Fillers are available in all types of gasketing materials.



SPIRAL WOUND METAL-TEFLON GASKETS will maintain tight joints where temperatures cause expansion or contraction of equipment. Used against acids, chemicals. Recommended for tube plates, manholes, handholes, flanges.



SPECIAL TEFLON GASKETS of all shapes can be furnished to your drawing or template. Also, Teflon-Treated Blue Asbestos Gasketing is ideal where a less expensive, yet strong, compressible seal is needed to resist acids.

Teflon gasketing is another part of "the Garlock 2,000" . . . two thousand different styles of packings, gaskets, and seals. Get more details from your Garlock representative, or write for Catalog AD-154.

**THE GARLOCK PACKING COMPANY
OF CANADA LTD.**

• General Offices: Toronto, Ont.
Branch Offices: Hamilton, Montreal, Winnipeg, Edmonton, Vancouver

*DuPont Trademark for T.F.E. fluorocarbon resin

GARLOCK

*Packings, Gaskets, Oil Seals, Mechanical Seals,
Molded and Extruded Rubber, Plastic Products*



Canadian Division: The Garlock Packing Co. of Canada Ltd.

Plastics Division: United States Gasket Company



Any screw machine part to meet your need

We'll make it out of brass, steel, aluminum or any machineable material to meet your specifications. A battery of 66 multiple and single spindle automatic screw machines (capable of machining from 1/32" through to 2 3/8" diameter material) are ready to go to work. For the highest production quality, in any quantity at the lowest cost—call in Weatherhead.

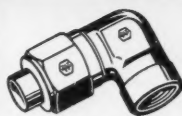


WEATHERHEAD



SCREW MACHINE DIVISION
St. Thomas Ontario

SM-3-8



S.A.E.
FLARE-TWIN
(J.I.C.)



SELFALIGN®



BULK HOSE
AND REUSABLE
HOSE ENDS



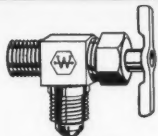
HOSE
ASSEMBLIES



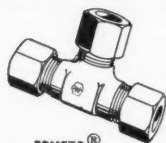
DASH
CONTROLS



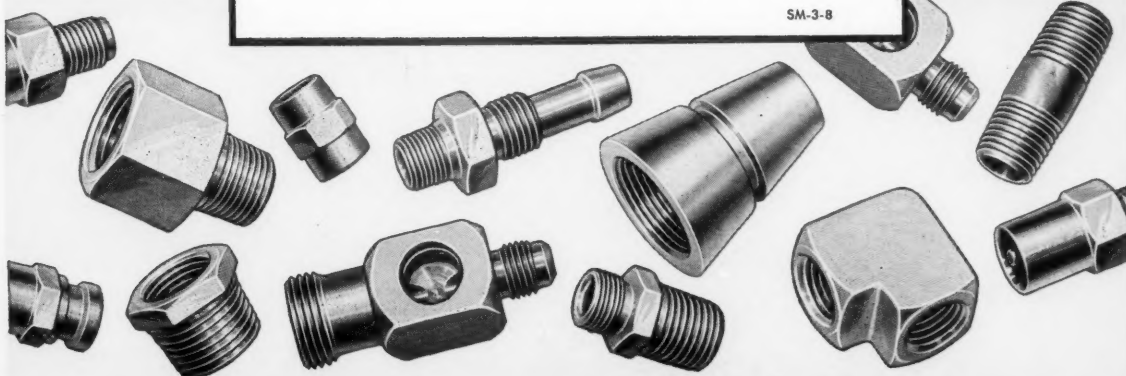
BRASS



DRAIN AND
SHUTOFF COCKS



ERMETO®



For further information mark No. 163 on Readers' Service Card



Is YOUR pencil
sharpened to reduce
manufacturing costs?

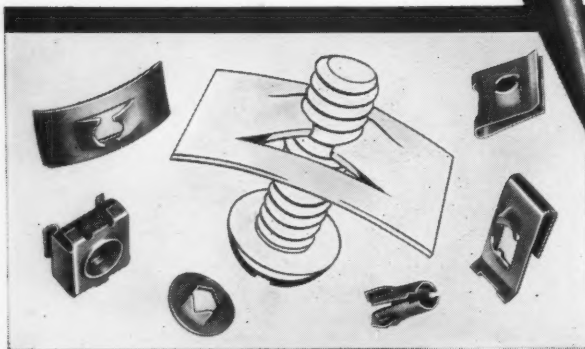
There are a lot of sharp pencils in use these days
— production costs *must* be kept in line to meet
increasing competition. Speed Nuts are specially
designed fasteners that save time and money
on *every* assembly operation. There are 8,000
kinds now in use, and we will gladly design
types to meet *your* special needs.

*If you're interested
in lower costs you'll
be interested in*

DOMINION FASTENERS

Speed Nuts®

Exclusive TINNEMAN Canadian Licencee



DOMINION FASTENERS LIMITED

a Geo. A. Tinneman corporation

HAMILTON, ONTARIO. Sales Branches: Toronto, Montreal

Like most manufacturers, I want to get my production
costs down. Please rush complete information on how
Speed Nuts can help me.

NAME

COMPANY

ADDRESS

WE MANUFACTURE

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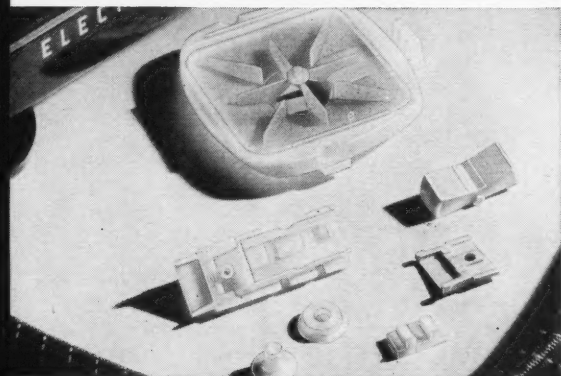


PRODUCT ENGINEERING

TYPICAL APPLICATIONS OF MOULDED NYLON

NEWS

"ZYTEL" Nylon Mouldings Selected for Key Parts in New Electrolux Vacuum Cleaner



Mouldings from Du Pont's versatile "Zytel" type 66 nylon — intensively used for key components in the new "Elux-o-matic" vacuum cleaner — have more than lived up to expectations during rigorous testing programs and months of product use in homes.

"Zytel" nylon parts were specified in the original design by Electrolux (Canada) Limited because, as the company states, after 15 years of experience in the use of plastics indicated to the product's designers that the easy-moulding characteristics and high strength/weight ratio of "Zytel" nylon could provide all the necessary and desired properties at the lowest cost.

The toughness, resilience and electrical properties of "Zytel" nylon proved to be exactly what was needed in such vital components of the "Elux-o-matic" cleaner as the switch-holder and foot switch, the motor core insulator, the air-filter frame and its clamp block, the motor switch housing, and various bearings and bushings.

"Zytel" nylon was first choice for the power cord strain-relief clamp. This particular piece, which was moulded by GENERAL TIRE AND RUBBER COMPANY OF CANADA LIMITED, WILLOWDALE, ONTARIO, required the extreme toughness and resilience of nylon to absorb the repeated shocks and strains of the cord-winding mechanism.

The large air-filter frame, moulded by ROBINSON INDUSTRIAL CRAFTS LIMITED, OF LONDON, ONTARIO, is an application where the strength and light weight of nylon is put to advantage. If made of metal, this part would be heavier, more expensive and subject to damage in assembly and subsequent use.

The excellent electrical insulation and heat resistance properties of "Zytel" were specified to save weight and space in the motor core insulator. The moulder, BLAINES PLASTICS CO., LTD. OF ST. HYACINTHE, QUE., found that "Zytel"

readily lent itself to the close tolerance moulding and thin sections required in this part. It could withstand operating temperatures of 250°F. for lengthy periods.

Complex mouldings are made possible by the good flow characteristics of "Zytel" nylon. MIDLAND PLASTICS, OF MIDLAND, ONTARIO, experienced no unusual difficulty in producing the switch-holder for the "Elux-o-matic" cleaner, said to be the most complex part ever moulded of nylon in Canada. Tolerances are held to .002 inches, as required for this application, without any need for post-moulding treatment. The versatile properties of "Zytel" nylon enable the switch-holder to act as its own insulator, at the same time supporting the operating load on the foot-switch — also moulded from "Zytel".

The rapidly increasing use of "Zytel" nylon in a wide range of important products reflects the confidence that today's manufacturers place in this dependable plastic. All across Canada, designers are realizing the interesting and unusual possibilities in design allowed by "Zytel" nylon's unique combination of strength, electrical resistance, toughness, heat resistance, and ease-of-moulding. "Zytel" nylon also is non-rusting and non-corrosive. It has a low co-efficient of friction, is self-lubricating, absorbs shock and vibration, and resists abrasion. In many cases where metal parts have previously been used, "Zytel" nylon has saved money and done a superior job.

"Zytel" nylon resin, made by Du Pont in Canada from Canadian materials, has demonstrated its versatility, has improved efficiency, and saved money for many Canadian manufacturers. "Zytel" nylon can do the same for you in some application. Contact your moulder, or write for detailed information to:



**DU PONT OF CANADA
LIMITED**

PLASTICS DIVISION
P.O. BOX 660, MONTREAL, QUE.

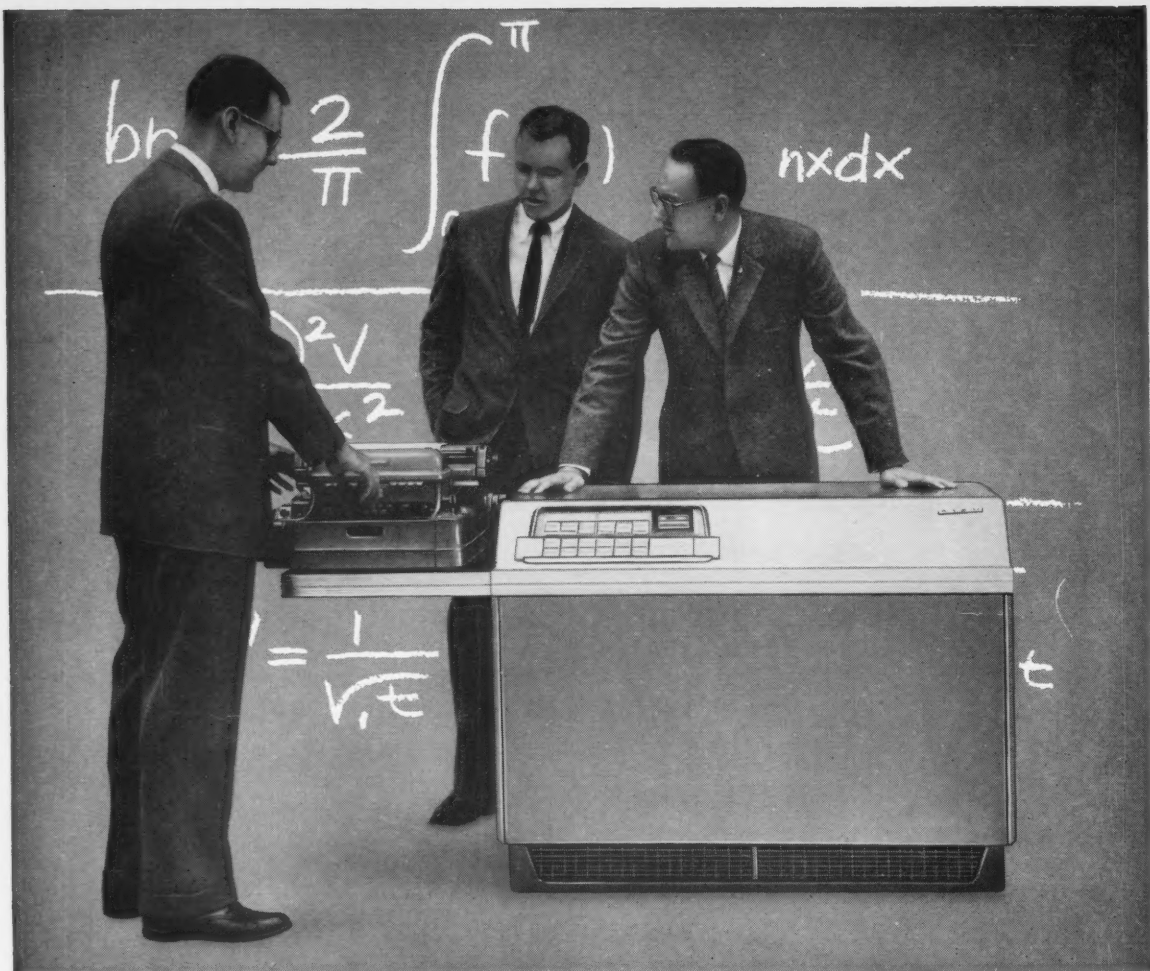


Better Things for Better Living...through Chemistry

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DU PONT

PLASTICS



Speed routine calculations—increase creative time with this powerful electronic computer McBEE LGP-30

Large capacity... easily programmed and operated... mobile... low in cost

Compact, simple to use, McBEE LGP-30 will today bring high-speed computation *right to your desk*... thus relieve you of the tedium of standard hand calculations... increase available time for truly creative work... help you simulate optimum designs in a matter of minutes. And at the lowest cost ever for a complete computer system!

Unusual capacity. Operating from a standard wall outlet, performing an almost unlimited range of calculations, LGP-30 gives you the flexibility of stored-program operation combined with speed, memory (4096 words) and capacity equal to computers many times its size and cost. Completely mobile, LGP-30 is easily wheeled from room to room, building to building.

Simple to operate and program. LGP-30 controls have been so

thoroughly simplified that it may be operated with only minimum computer experience. Direct print-out of answers—no deciphering required. Programming is easily learned—even by non-technical personnel. Library of sub-routines, plus programs for a wide variety of applications, is available.

Wide range of applications. In addition to general design and system optimization, LGP-30 is currently being used for the refinement of estimates; computation of design parameters; specification of new product properties and capabilities; calculation of such data as reactance, load saturation curves, time constants, harmonics, torque-speed and vee curves.

Exceptional value; complete service. Smallest initial investment ever for a complete computer system is combined with low operating and maintenance costs.

For further information and specifications, write Dept. 30.

McBEE

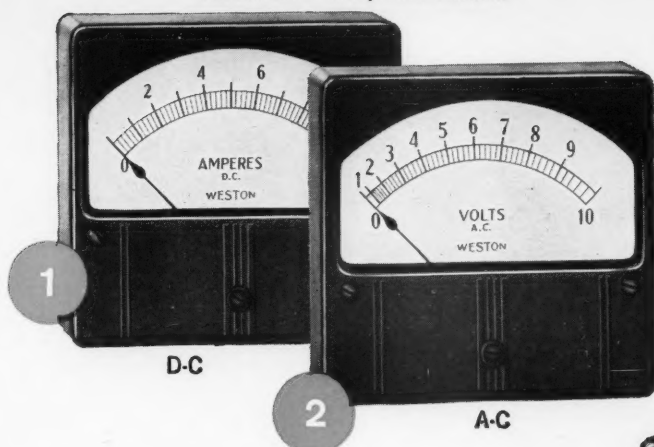
FOR PRACTICAL
OFFICE AUTOMATION

The McBee Company Limited, 179 Bartley Drive, Toronto 16, Ontario

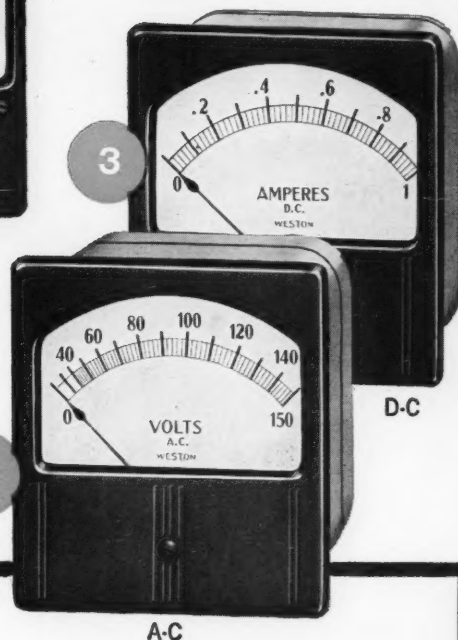
OFFICES IN PRINCIPAL CITIES ACROSS CANADA

For further information mark No. 139 on Readers' Service Card

Model 961 Group Instruments



Model 741 Group Instruments



*Feature by
Feature*

THESE WESTON RECTANGULARS LEAD THE FIELD

The well-balanced design, fine appearance and desirable features of these Weston instruments reflect a 70-year tradition of fine engineering and craftsmanship. If you're not already well acquainted with these notable models, look over this check list — you'll not find better value anywhere.

For full information, write to Daystrom Limited, 840 Caledonia Road, Toronto 19, Ontario or 5430 Ferrier Street, Montreal, Que., a subsidiary of Daystrom Incorporated, or any office of Northern Electric Co. Ltd.

- ① ② ③ ④ Long scales (Model 961 Group: 3.17" . . . Model 741 Group: 3.24" A-C and 3.52" D-C)
- ① ② ③ ④ Excellent natural illumination (self-contained lighting optional)
- ① ② ③ ④ High rated accuracies (Model 961 Group: 2% of full scale value . . . Model 741 Group: 1%)
- ① ② ③ ④ High sensitivities . . . low response times
- ① ② ③ ④ Excellent torque-to-weight ratios
- ① ② Dielectric test — 5000 volts A-C
- ② ④ Group includes A-C rectifier type instruments
- ① ③ D-C and rectifier type instruments have magnetic shunts for precise adjustment

These instruments are particularly suitable for a wide variety of specialty applications where other than cataloged accuracies are desirable.



WESTON

Instruments

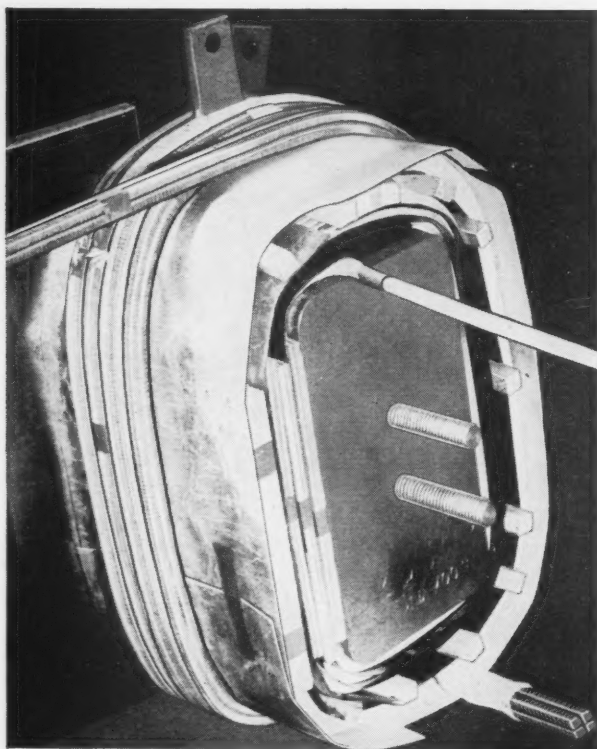
WORLD LEADER IN MEASUREMENT AND CONTROL

For further information mark No. 120 on Readers' Service Card

5928

lower production costs

on "Class B" and "Class F" windings with



*Phelps-Dodge registered Trade Mark

FEDERAL DAGLAS* MAGNET WIRE

Unique mechanical properties, such as extreme flexibility, resistance to abrasion and damage from forming, make Daglas magnet wire the ideal material for all "Class B" and "Class F" windings.

Daglas magnet wire consists of bare or enamelled copper wire, wrapped with a combination of Dacron and glass and heated to fuse the glass fibres in place. An overall coating of varnish is applied, providing a smooth finish and improved resistance to abrasion. Daglas can also be supplied without varnish if required.

Daglas is supplied in square and rectangular sizes from #14 to #1 AWG and in round sizes from #23 to #1 AWG, with "Class B" and "Class F" ratings.

Daglas has greater flexibility. In sharp bends where ordinary glass insulation cracks badly, Daglas leaves no wide open cracks—adheres perfectly.

Superior adhesion of Daglas insulation prevents unravelling and separation even when twisted. Greater resistance to damage from abrasion.

When conductors are elongated to breaking point Daglas still adheres tightly—no fraying at the ends and no unravelling as with ordinary glass insulation.

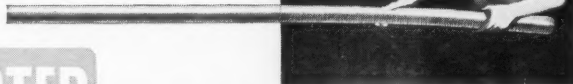
BEND IT...



TWIST IT...



STRETCH IT...



5902

FEDERAL WIRE

PORTER

& CABLE DIVISION

H.K. PORTER COMPANY (CANADA) LTD.

PORTER SERVES INDUSTRY: with Rubber and Friction Products—THERMOID DIVISION; Electrical Equipment—DELTA-STAR ELECTRIC DIVISION, NATIONAL ELECTRIC DIVISION; Specialty Alloys. RIVERSIDE-ALLOY METAL DIVISION; Refractories—REFRATORIES DIVISION; Electric Furnace Steel—CONNORS STEEL DIVISION, VULCAN-KIDD STEEL DIVISION; Fabricated Products—DISSTON DIVISION, FORGE AND FITTINGS DIVISION, LESCHEN WIRE ROPE DIVISION, MOULDINGS DIVISION, H.K. PORTER COMPANY de MEXICO, S.A., and in Canada, Refractories, "Disston Tools," "Federal" Wire and Cable, "Nepco" systems H. K. PORTER COMPANY (CANADA) LTD.

For further information mark No. 143 on Readers' Service Card



Cutaway shows compact interior design and construction of a typical Cleveland worm speed reducer, used in thousands of plants. Cleverlands save floor space—are simple to install and maintain. A minimum number of moving parts practically eliminates trouble.

Why WORM gear? Why CLEVELAND?

HERE are some of the inside reasons why Cleveland worm gear speed reducers are specified by many of the leading builders and users of industrial machinery.

- **SAFE, SPACE-SAVING, RIGHT-ANGLE DRIVE**—Cleveland worm gear speed reducers provide a wide range of reduction speeds. Worm and gear enclosed in sealed housing replace dangerous open gearing, belts and pulleys. Safety always for machine operators and lube men! Gearing runs in oil bath, insures positive lubrication, eliminates oil cans and grease paddles.
- **SMOOTH TORQUE FLOW**—By virtue of the sliding action of worm on gear, a Cleveland transmits power uniformly and smoothly. Constant angular velocity assures positive control of work on driven machine.

Get the complete Cleveland story by writing for Catalog 400 today. Peacock Brothers Limited, P. O. Box 1040, Montreal 3, Que. Branches in Sydney, Toronto, Sudbury, Winnipeg, Edmonton, Calgary, and Vancouver.



Made
and Sold
in Canada
by . . .



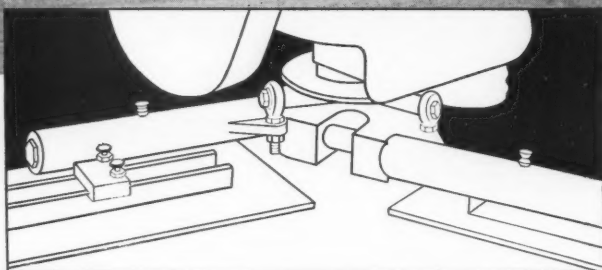
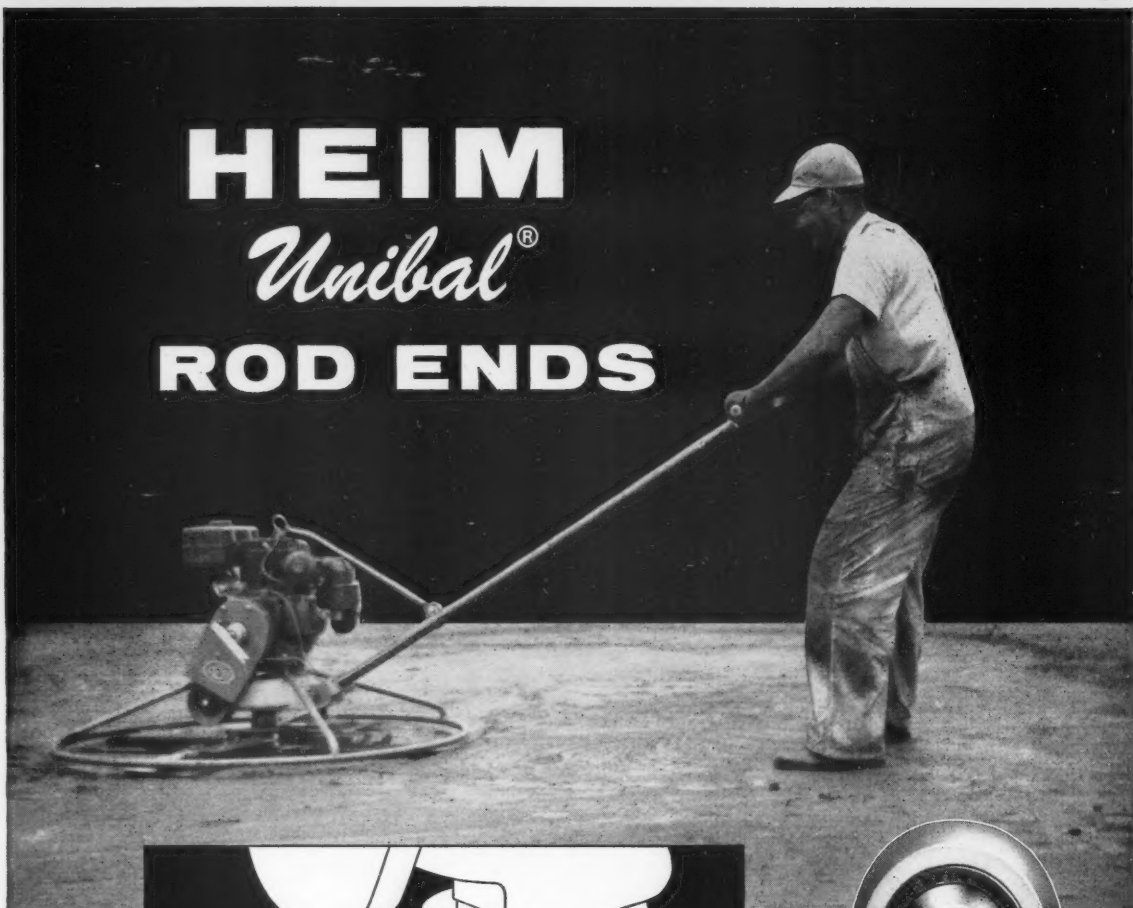
PEACOCK BROTHERS LIMITED

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HEIM

Unibal[®]

ROD ENDS

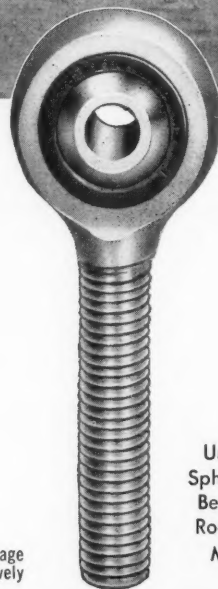


For Positive Control of Tilting Action

The blades of the Stow Roto-Trowel tilt to the required pitch for finishing new concrete surfaces. Turn up the control knob on the handle to push down on the tilting plate for a higher angle of the arms and blades. This action requires a self-aligning bearing which must transmit a thrust load and rotate at the same time. Selected by the Stow Mfg. Co. of Binghamton, N. Y., as the perfect connection between the actuating rod and the pivoting and rotating blade arm was the **Heim Unibal Spherical Bearing with Sintered Iron Ball**.

Here is another simple but ingenious application of the Heim Rod End in a mechanical linkage where an improvement in the operation has been accomplished. Combined in a comparatively small unit are all the elements necessary for trouble-free, peak performance:

- Load ratings more than adequate for the job.
- Self-lubrication in the sintered iron ball, with an oil capacity 20% of its own volume.
- Correction of misalignment inherent in the motions of the blade arm and control rod.
- Quick and easy installation at low cost.
- Long life under rough, exposed conditions.
- Replaceable without complete disassembly of the machine.



Unibal
Spherical
Bearing
Rod End—
Male

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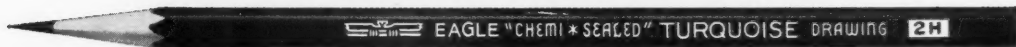
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clearer with
Eagle Turquoise



TURQUOISE LEAD HOLDERS hold any TURQUOISE lead (5B to 9H) in a bulldog grip.



TURQUOISE DRAWING PENCILS are made in 17 degrees, 6B to 9H.



TURQUOISE WITH ERASER, in grades 4B to 6H, is increasingly popular as a field tool.

We've run tests on every drafting material made—including some that aren't even on the market yet! On all of them, TURQUOISE consistently out-performs other pencils.

Here's why: the strong TURQUOISE needle-point stays sharp longer. You get the world's cleanest lines—for the world's sharpest reproduction. TURQUOISE'S "electronic"

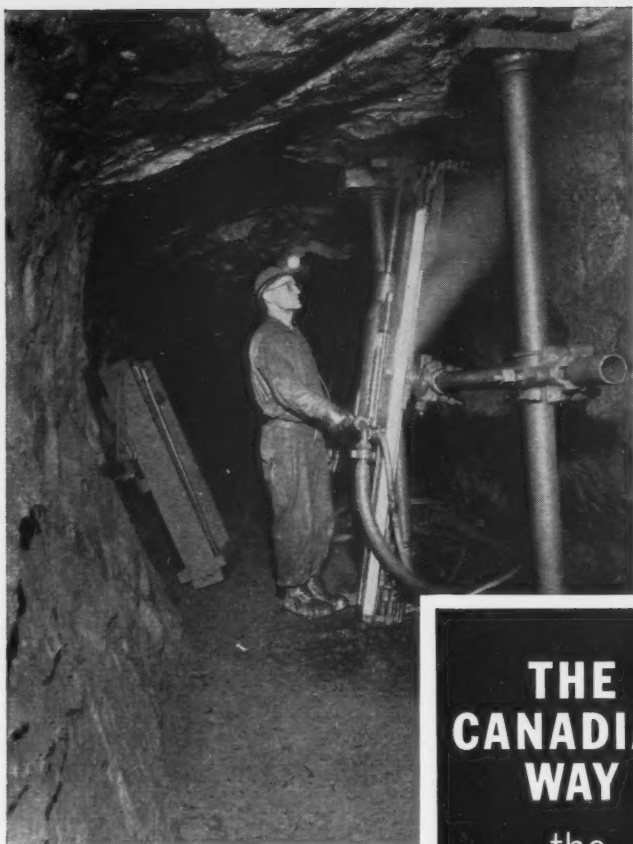
graphite glides more smoothly (without skipping) over every material. And these superior qualities are combined with perfectly uniform grading—pencil after pencil!

So why switch pencils when you switch drafting surfaces? Standardize on Eagle TURQUOISE!



WANT A FREE SAMPLE? Write for a TURQUOISE pencil or lead, in the degree you'd like to test on your favourite drafting material. Eagle Pencil Company of Canada Ltd., 217 Bay St., Toronto 1.

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feed growing
world industry*

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...the
best way for
Canadians



*Wealth in ideas
from Canada's
own periodicals*

Minerals from Canada are the vital raw materials for a large part of world industry. We are the leading producers and suppliers of nickel and asbestos; rank second in gold, platinum, gypsum, zinc and selenium; third in silver, cobalt, magnesium and molybdenum; fourth in iron ore; fifth in lead and copper. In the atomic age, Canada is in a neck-and-neck race with the United States as the leading supplier of uranium. In Manitoba, another Sudbury is mushrooming at the World's second largest nickel deposit. In Labrador and Quebec, new cities are growing as the Golden Horseshoe of vital iron is tapped for tomorrow.

In this richly endowed land ideas are the well-spring of progress — Canadian ideas speed commercial and industrial development. As Canada's leading national publishers, Maclean-Hunter magazines, financial and business publications interpret world events from a Canadian point of view; they report news of interest to the Canadian public and business community. They foster the growth of Canadian art and literature. They are, in fact, part of the Canadian way . . . the best way for Canadians.

MACLEAN-HUNTER

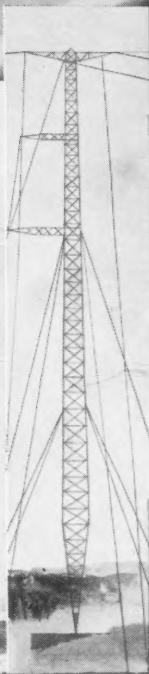
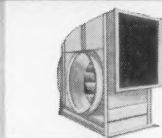
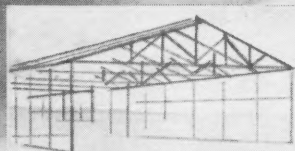
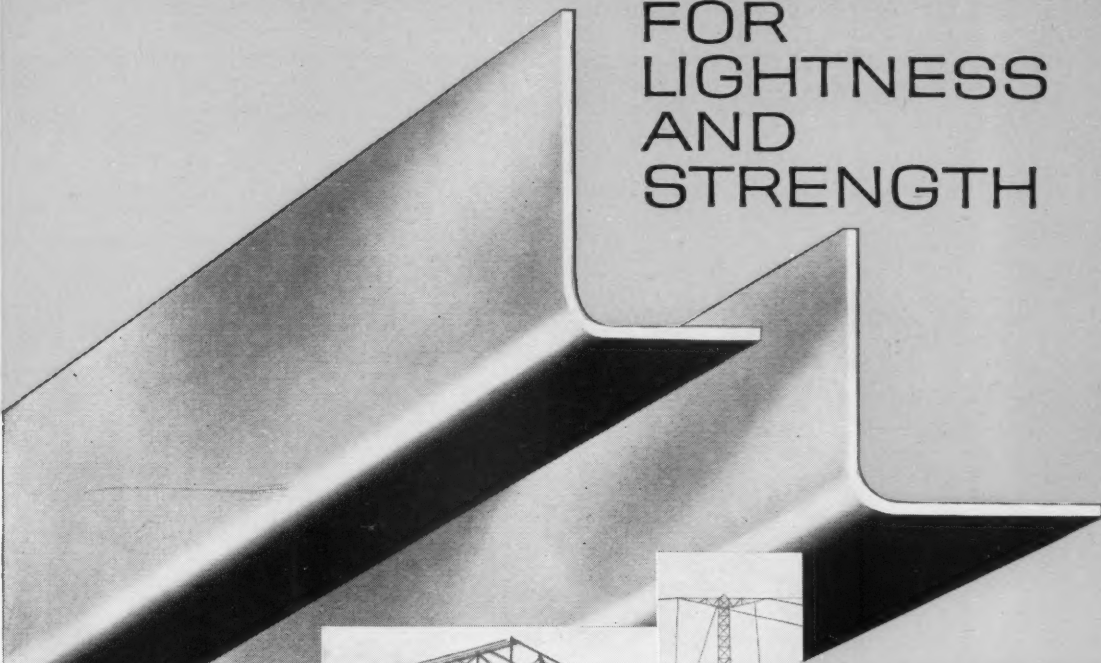


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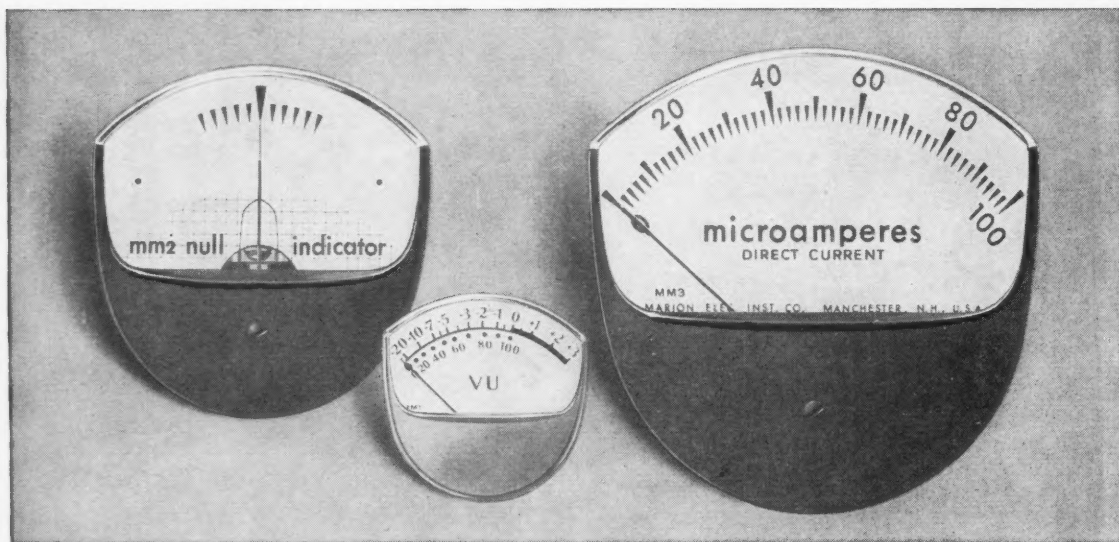
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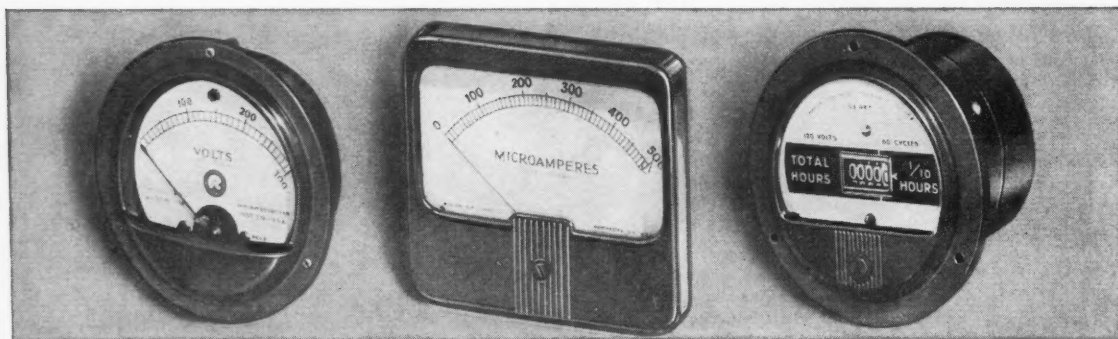
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more economically!*



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This handsome Golf Cart, molded by Protective Plastics for Electricar of Canada Limited, is yet another example of the promised potential of VIBRIN reinforced polyester. Strength combined with lightness, corrosion resistance, freedom in product design and low cost tooling extend the product possibilities of Vibrin far beyond conventional applications.

Bodies for vehicles of all types, housings and component parts for a multitude of products, furniture, building materials, watercraft and piping are but hints of Vibrin's true potential.

Learn how VIBRIN can help you mold greater profits. Our technical staff are at your service, to help improve present products or to create new ones. Simply contact Naugatuck Chemicals at Elmira, Ont., or our branches in Montreal, Toronto, Winnipeg or Vancouver.

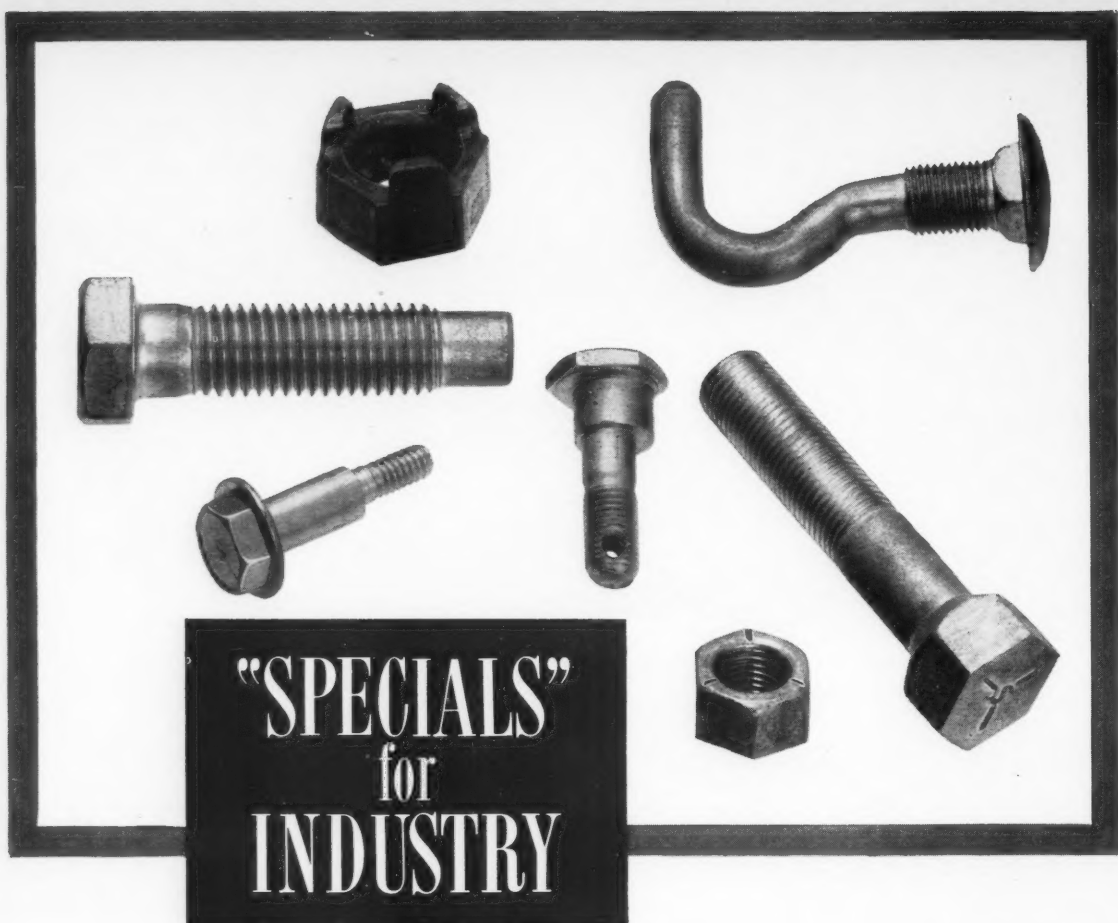
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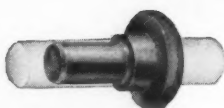


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• *Produced economically to customer requirements!*



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Five of the pieces shown above are produced by cold heading plus additional secondary operations.

Starting with wire of any forgeable metal up to 1" in diameter, Stelco can upset it to at least $4\frac{1}{2}$ times its original diameter to produce contoured components for industry.

Cost reductions of 40% and higher are not unusual when a part is produced by cold heading or hot forming, with secondary operations where necessary, rather than by machining. This saving is realized because material scrap loss is avoided and production rates are increased.

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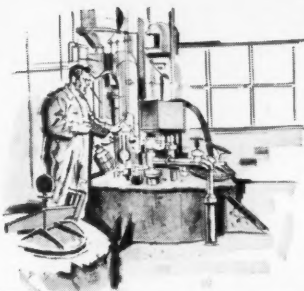
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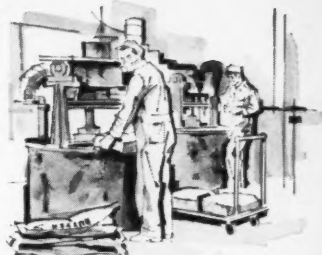
INSIDE STORY



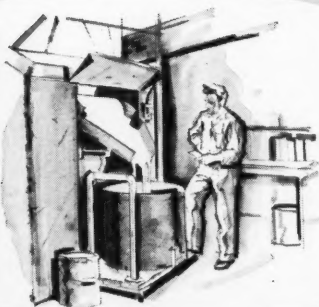
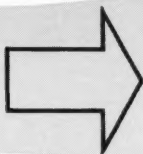
A 65 second tele-view
of the quality control
story behind **CPI**
INDUSTRIAL FINISHES



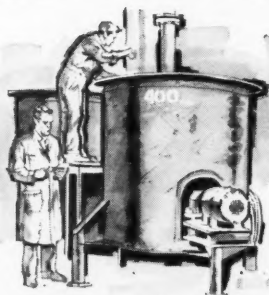
CPI makes its own alkyd resins in these kettles in order to insure high quality finishes right from the start. Rigid control is maintained over this vital process.



Here exact weight quantities of pigments and liquid vehicles are thoroughly mixed and blended before grinding. The mixture gets its ultimate smooth consistency in a battery of heavy duty grinding machines.



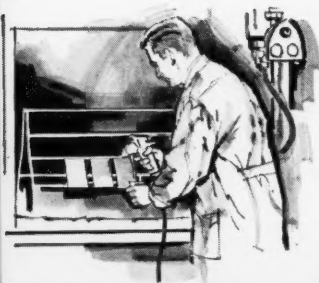
When a high gloss finish is specified, a very fine, uniform grind of pigment is essential. This 5-roll mill does the job.



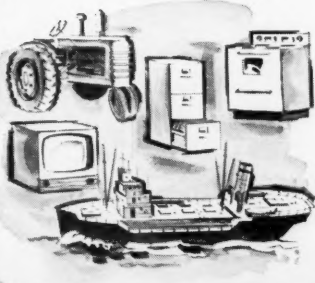
Exact colour matching and thinning to correct viscosity are done in these modern self-agitating tanks by CPI's specialists.



This is a CPI Weather-ometer. It creates accelerated weather conditions under which the performance of CPI finishes is proved right in the laboratory.



Further lab testing—in this spray booth application properties are checked. CPI industrial finishes must meet a customer's exacting requirements before release for shipment.



Almost everything you see or use needs the beauty and protection that a modern industrial finish can give. And if that finish is made by CPI it will look better, last longer ... cost less in the long run!

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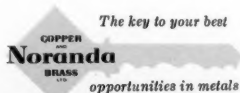


HE'S HELPING TO CUT YOUR COSTS

Here a workman is taking a sample of 99.9% pure Noranda copper for laboratory analysis. This is one of a long series of tests, made at various stages of production, by which Noranda assures the highest standard of quality in brass mill products.

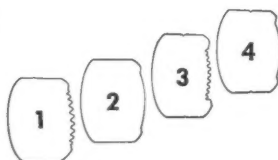
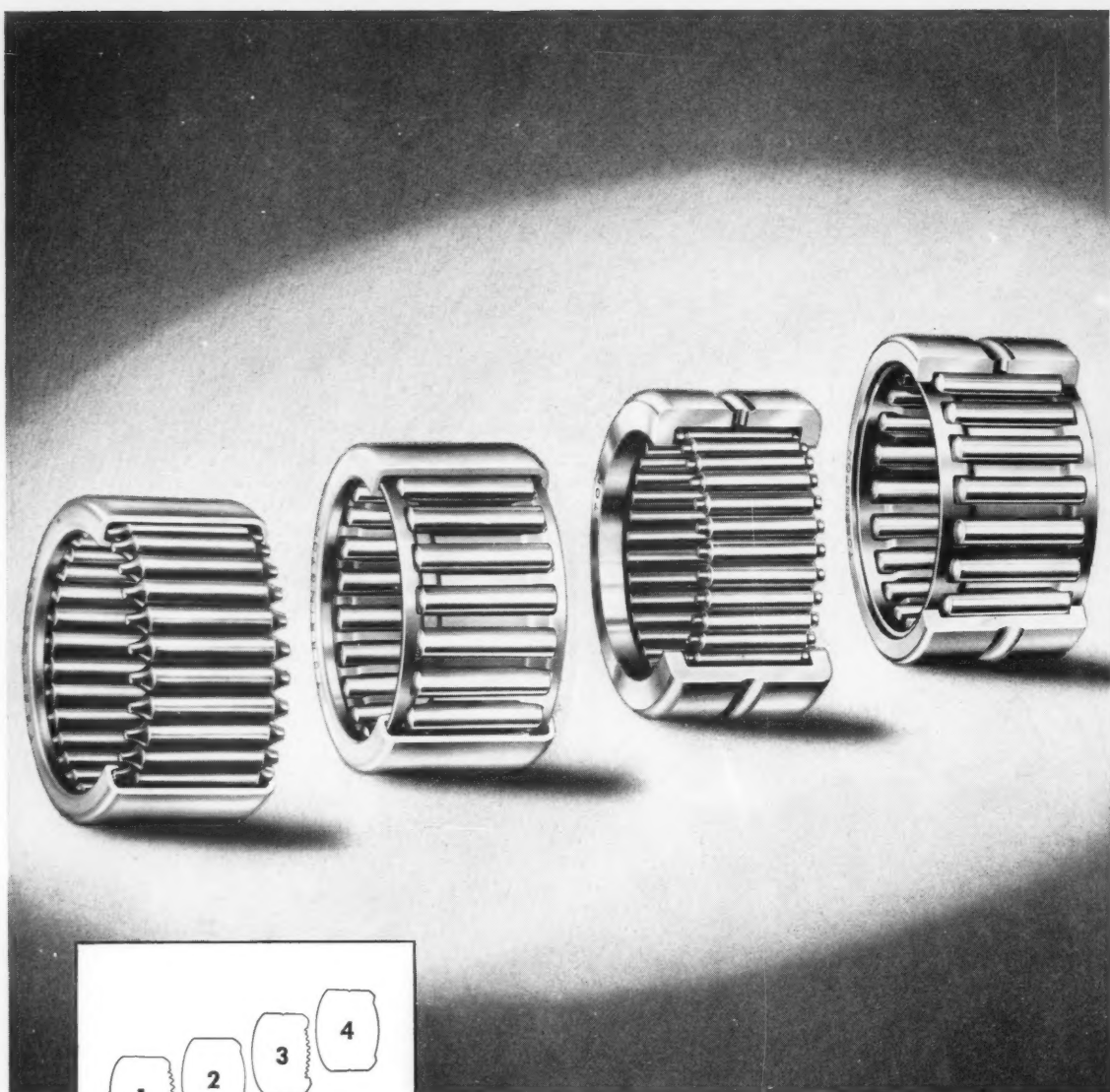
When you use Noranda copper or copper base alloys in the form of strip, rod, wire or tube, you benefit from this inte-

grated control of quality from mine to finished metal. It shows up in greater fabricating efficiency...fewer rejects...smoother production at lower costs. It is helping many manufacturers, in both domestic and overseas markets, to produce more profitably. May we show you how it can help you improve your product or your manufacturing operations?



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Torrington Drawn Cup Needle Bearing...
for maximum radial capacity in minimum cross section... positioned by press fit—snap rings or shoulders unnecessary... runs directly on hardened shaft... most compact, light weight, economical.

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Torrington Heavy Duty Needle Bearing...
for use with thin section or split housing where extreme impact loads require heavy outer race... maximum shock resistance... full roller complement... unit construction.

Torrington Heavy Duty Roller Bearing...
for combination of high speed, long pregreased life or shock resistance... roller stability provided by end-guiding... flange-riding retainer... unit design.

All of these types of bearings are available with inner races.

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Torrington developed the Needle Bearing and its specialized variations. This breadth of experience assures impartial engineering recommendations based on specific application requirements. You can rely on Torrington to recommend the most compact and economical design compatible with operating conditions and performance requirements. Call on your Torrington representative for help in applying the right bearing in the right place. **The Torrington Company, Limited, 925 Millwood Road, Toronto 17, Ont., Canada.**

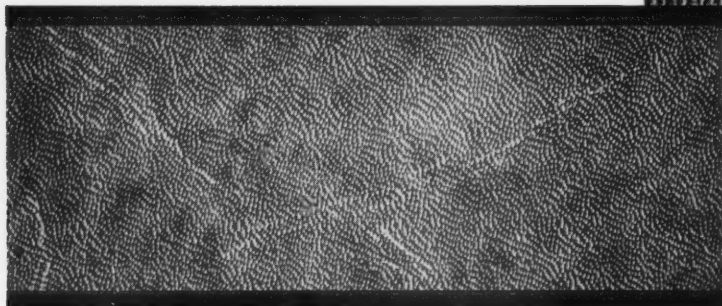
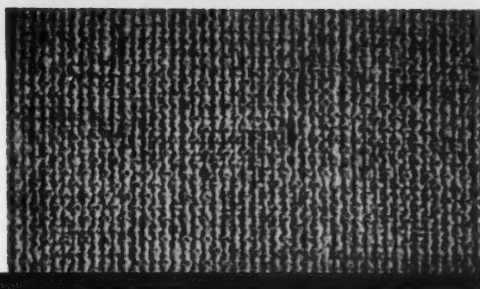
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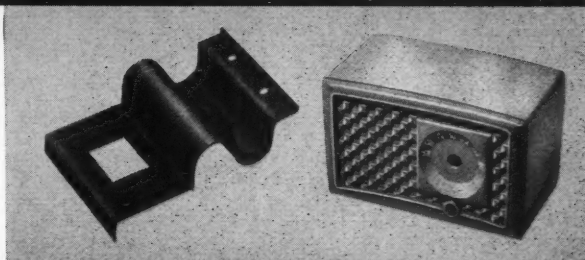
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what it can do!



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KladKoil can be rolled, drawn, stamped or formed into intricate shapes without fracturing or cracking. It's so flexible, the metal will break before the finish does!

KladKoil is available in a variety of rich, warm, textured colors. In the standard smooth finish, in paint or vinyl, an unlimited color range is available.

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KT922



QUALITY NICKEL PLATING



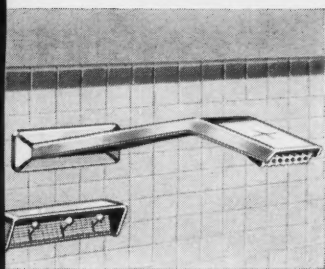
Look at this beautifully different oven. It features nickel-chrome lining. This gleaming bright surface reflects heat better for faster preheating, more even baking and roasting. And how easy it is to clean! Soap and water's usually all that's necessary . . . because grease, burned foods and juice sugars just can't get a grip.

Quality is perhaps the most important of the many factors which combine to make up sales appeal and acceptance. Take this beautifully styled electric range, for example. It's a brilliant new concept in design . . . the last word in cooking efficiency with its slide burner units, dropleaf cutting board, built-in rotisserie, automatic timers and heating controls.

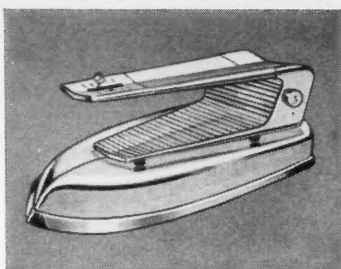
But it is the *quality* of these components that is most important to the consumer. For instance, the two large oven units in this electric range are equipped with mirror-bright interior linings plated with nickel under chrome. *Quality* nickel plating provides a smooth, bright-metal foundation for a lasting, satin-smooth chrome finish. In today's competitive market it is quality that adds up to sales acceptance . . . helps to *sell* the consumer . . . again and again.



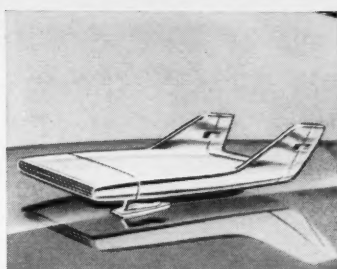
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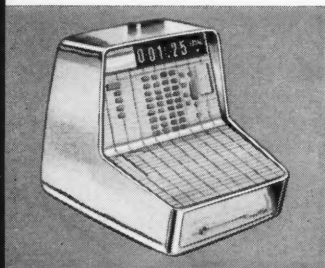
Newest designs in bathroom accessories are more attractive when nickel-chrome plating is used. Cleaning is easier and base metals don't corrode.



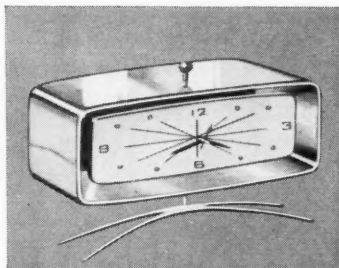
Electric irons and many other household appliances when plated with nickel under chrome stay bright, smooth and beautiful for years.



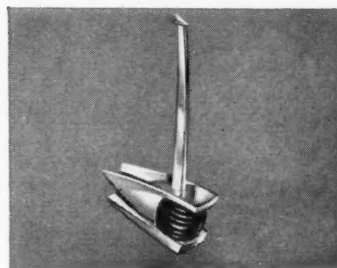
On automobile ornaments and trim, chromium plating adds gleam. But the heavy nickel plating underneath protects the finish—makes the beauty last!



Cash registers, too, can be glamorous. Tough, durable nickel plating under chrome gives lasting appeal.



The bright lustre of nickel-chrome plating adds emphasis to the design features of many of today's modern accessories for the home.



Marine hardware is constantly threatened by corrosion. New designs are made exciting, highlighted and protected by nickel-chrome plating.

designed for sales appeal

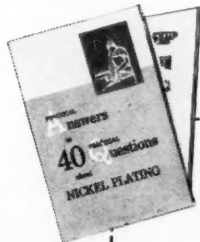
With the accent on sales appeal, today's trend is toward glamour-styling in electrical appliances and many other articles for consumer use. And nickel-chrome plating gracefully highlights these glamorous designs with its glowing, lustrous depth of beauty.

Design engineers can be assured of high consistent quality by specifying adequate thicknesses of nickel-

chrome plating. Better performance — with long corrosion-free service — go hand in hand with specification plating.

The nickel plating industry can now offer a much wider range of predetermined properties through assured supply of nickel and improved plating methods.

For more information about how nickel plating can benefit your products, mail the coupon for free booklets: "Practical Answers to 40 Practical Questions about Nickel Plating" and "Industrial Nickel Plating."



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ORIFICES	1/16" THROUGH 3/16"	1/8" AND 3/16"
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DUTY	CONTINUOUS	CONTINUOUS
POWER CONSUMPTION	10-20 WATTS	10-20 WATTS
HEAT RISE	WITHIN UL LIMITS	WITHIN UL LIMITS

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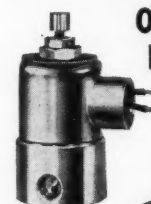
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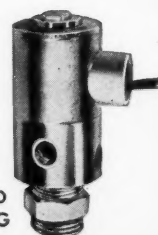
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Every HYGRADE Corrugated Container is exceptionally rugged. It combines superior design and quality material (100% C-I-P Kraftliner), backed by HYGRADE's up-to-the-minute production and service facilities... a top-notch team that can tackle any problem.

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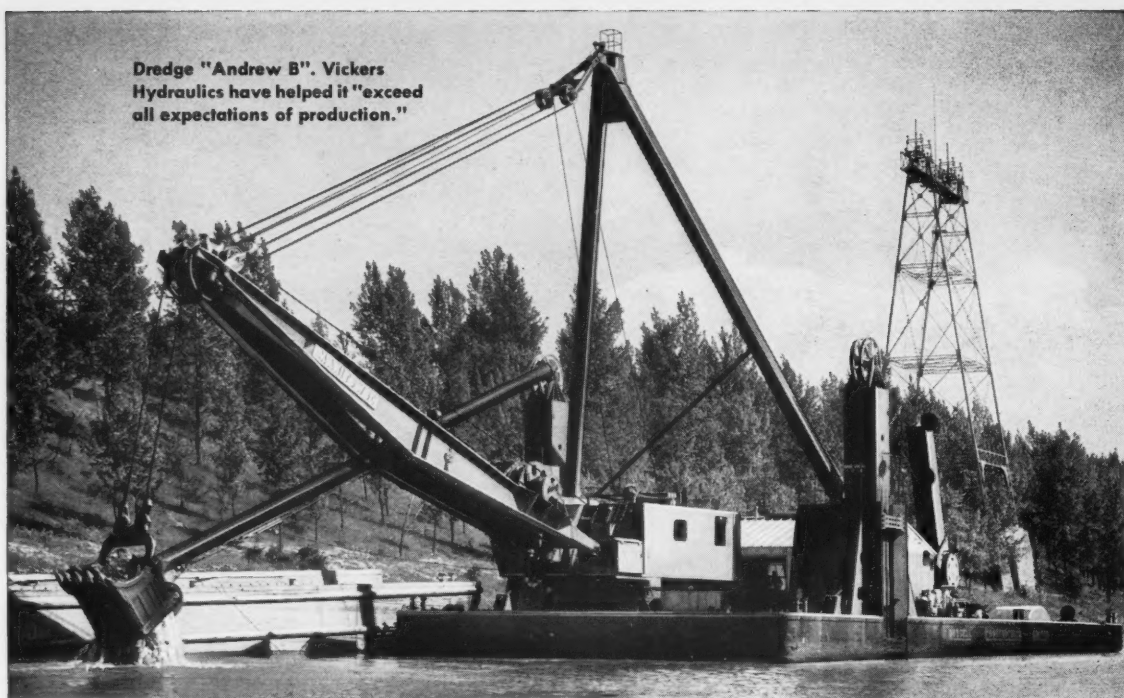


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Plants: LONDON — TORONTO — MONTREAL

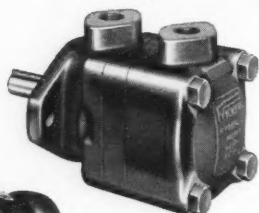
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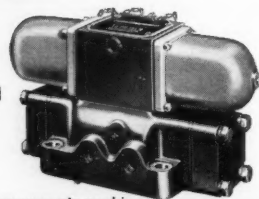
New Production Records Set by "Dredge of Tomorrow" With Help of a **VICKERS** Hydraulic System

Vickers Vane Type Hydraulic Motor



Vickers Piston Type Hydraulic Pump

Vickers Solenoid Controlled Directional Valve



Above are some of the components used in the "Andrew B" Vickers Hydraulic System.

Built by Port Weller Dry Dock Limited, the "Andrew B" has been called the "Dredge of Tomorrow". Its owners, the Russell Construction Co. Ltd. report that it has set new production records for 24 hour service on the Welland Canal.

The spuds (used to secure the position of the dredge) are raised and lowered with Vickers hydraulics much faster than by any previous method. Warping winches for handling of dump scows alongside the dredge are also economically and positively powered by Vickers hydraulics.

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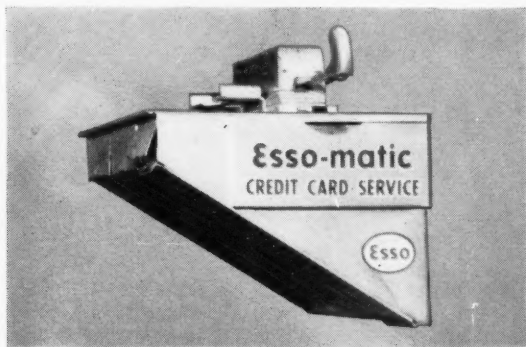
ATLAS steels solved these metal problems



Cutter blades on dredge suction head interlaced with high strength Atlas SPS-245 Machinery Steel bars overcame problem of rocks and boulders entering suction pipe and damaging pumping equipment.



Switching to Atlas type 301 stainless for concave cap sections on cupboard door knobs solved 30% reject problem caused by plating solution leakage in original product.



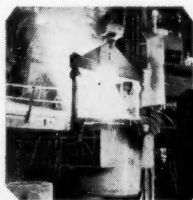
For long-life, corrosion-free service, type 302 stainless steel was used for outdoor service station charge plate mounting units. It replaced plated steel, which failed because of rust and wear after only four years of service.



The Atlas Crodi Tool Steel master hob (right) was used to pressure cast cavity dies in beryllium copper for plastic toy truck box. The impression, with deep reinforcement ribs left as cast, cut labour cost 30% over normal machining.

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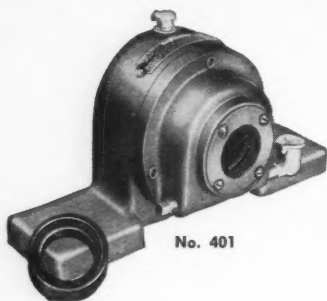
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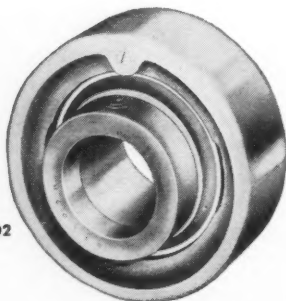
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No. 401

Transmission Unit for High Temperature Locations

Specially designed for applications involving higher than usual temperatures, Fafnir SAL type (standard) and SAOL type (heavy series) ball bearing power transmission units, utilizing water-cooled end covers, have been successfully mounted in close proximity to ovens, fans, etc. which have had inside temperatures as high as 1,500°F. The amount of water used is small; the flow through a 5/16 in. copper tube generally being quite sufficient. The bearing lubricant is kept cool by this method, thus avoiding a breakdown of the oil even when the bearing housing is close to the exterior of the oven wall or fan housing.



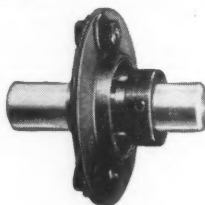
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Cylindrical Cartridges

Developed for ease of application, Fafnir Cylindrical Cartridges are convenient units for mounting in straight bored housings. All types incorporate a Wide Inner Bearing with Self-Locking collar and spherical outside diameter which is fitted to a corresponding spherical seat in the cartridge to provide self-alignment.

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Users can obtain the advantages of ball bearing performance at a new low cost with recently-introduced Fafnir Flangettes. The unit is comprised of two interchangeable pressed steel flanges which house a standard Fafnir Wide Inner Ring Ball Bearing with the exclusive Fafnir Self-Locking Collar, providing a complete, inexpensive housed unit for light duty, slow speed applications. They are compact, easy to mount, self-aligning, and pre-lubricated ready for installation. They are available equipped with either Plya-Seals (contact-type) or Mechani-Seals (slinger-type).



No. 403

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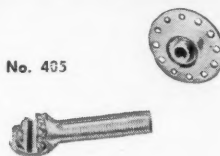


No. 404

Aircraft Bearings Solve Many Commercial Bearing Problems

A series of ball bearings developed by Fafnir to meet the special and exacting

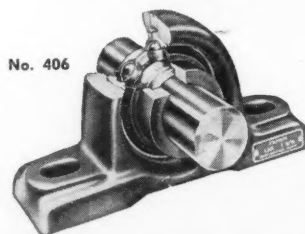
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requirements of the aircraft industry has found wide and rapidly broadening usage in many commercial applications where motion is reciprocating rather than rotational. Manufacturers of farm machinery, railway lighting equipment, lawn mowers, automatic machinery and other types of equipment have found the solution to a bearing problem in the Fafnir Aircraft Series.

Pillow Block for Normal Load Applications

Recommended for all general industrial applications where normal loads are encountered, Fafnir LAK Type pillow blocks offer many positive advantages. Compact, one-piece housing can be mounted in any position. Fitted with deep-groove single row wide inner ring bearings which are designed to carry radial, thrust or combined loads, and frictionless, integral Mechani-Seals for effective retention of lubricant and exclusion of dirt. The unit is pre-lubricated ready for immediate installation.



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Plotting graphical information

Here is some original thinking
on the subject of graphs in
carpet and lattice forms

W. H. Sheppard, B.Sc.(Eng.)

Notwithstanding that experimental data is invariably recorded in tabular form, it has long been recognized that plotting results is usually desirable, not only to recognize or determine trends, but also to observe and discount incident deviations

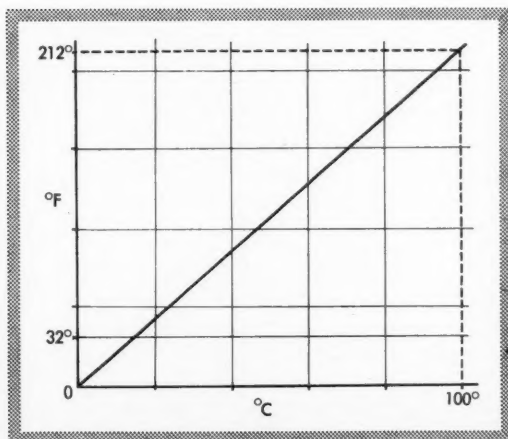


Fig. 1—Graph of Fahrenheit versus Centigrade scales

and also to evaluate numerical constants. Broadly speaking, graphs are of two classes (a) presentation of experimental data (b) graphs plotted to solve equations. It will be appreciated that in the case of (a) deviations are to be expected and the best line will be drawn through the points obtained. If possible, the Principle of Least Squares should be employed.

The simplest graph is the straight line $y = mx + c$ which permits interpolation and, to a limited extent, extrapolation. Simple power functions may be converted to linear by taking logarithms.

$$y = ab^x$$

Taking logs, Let $y = \log a + \log b$
or $\log y = \log b \cdot x + \log a$
i.e. $\log Y = m \cdot X + c$

If $a = 1$, $c = 0$ and the graph passes through the origin.

If $b = e$, $m = 1$ and the slope is unity.

Equations of the form $y = ax^2 + bx + c$ may be approximated to the parabola and again the Principle of Least Squares should be used, if possible.

Straight-line graphs

Considering a straight-line graph, the temperature conversion formula between Centigrade and

Fahrenheit $F = \frac{9}{5}C + 32$ is a good example (see

Fig. 1). The coefficient of increase of resistance of a metal with temperature is an example of a graph which starts as a straight line and then trends towards parabolic. It frequently happens, however, that it is desired to plot a series of graphs denoting the use of a series of constants or alterna-

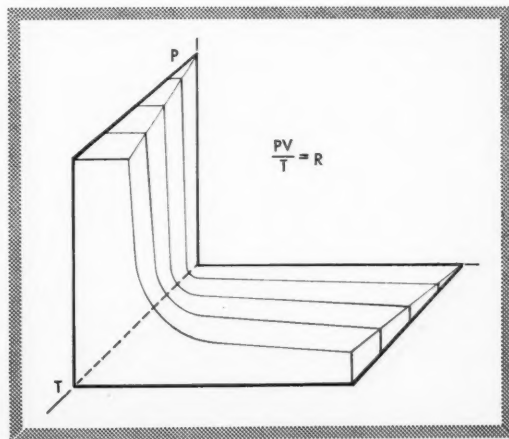


Fig. 2—Graph of the gas laws

tively the introduction of a third variable. In this case a series of graphs is plotted on the same axes and the result is in effect a contour map of the three-dimensional function. It will be appreciated that in considering three variables there are three alternative methods of plotting, treating each variable in turn as the "contoured" function. A good

example is the gas equation $\frac{PV}{T} = R$ which is represented in space by a hyperbolic cone. This may be plotted

- (a) $PV = R$ for a series of values of T .
- (b) $P/T = R$ for a series of values of V .
- (c) $V/T = R$ for a series of values of P .
- (a) gives the most interesting representation of the surface but (b) and (c) are more accurate for interpolation. Fig. 2 shows a picture of a surface but a series of surfaces may be plotted, one for each gas, giving in effect a fourth-dimensional representation. Actually it would be possible to make a three-dimensional diagram by developing the surface into a flat sheet. This is true of all developable surfaces but it should be noted that not all "ruleable" surfaces i.e. generated by straight lines are developable. An example of the latter is the hyperboloid of revolution.

Simultaneous equations

In the solution of algebraic functions, the most straight-forward method is to plot the function and observe the intersection with the appropriate axis. In many cases however greater accuracy may be obtained by taking a function in two parts. For example, let $\log x = \sin(x + a)$. The two graphs $y_1 = \log x$ and $y_2 = \sin(x + a)$ are plotted independently and the solution for x is given at the intersection of the graphs. If a has a series of values, then a series of graphs may be plotted for y_2 and appropriate values of y_2 determined.

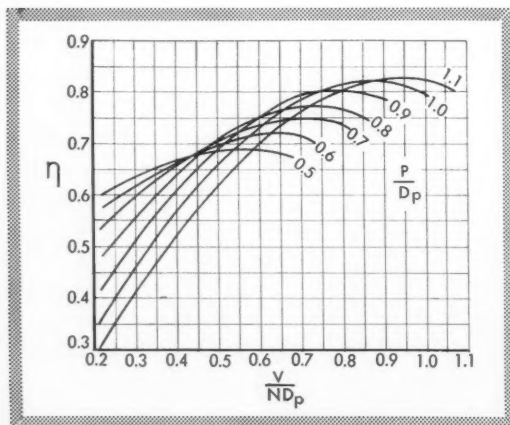


Fig. 3—Efficiency of two-bladed propeller

A straight line in space is denoted by the intersection of two surfaces and therefore by two equations connecting three unknowns. A point in space is denoted by the intersection of three surfaces. A good example is the equation connecting the three temperature scales

$$\frac{C}{5} = \frac{F - 32}{9} = \frac{R}{4}$$

With regard to the solution of equations, for extreme accuracy roots may be taken from graphs and then repeated to satisfy the equation by some form of calculator, or using Newton's method of successive approximation.

Triangular charts

Since the sum of the distances of any point in an equilateral triangle from the sides is constant, a chart constructed therein may be used to denote the relationship between any three functions whose sum is constant. Fig. 5 shows a very simple case denoting the relation between the three angles of a triangle. This principle may be extended, as for example in the projection of a cube $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = r^2 + s^2 + t^2 = 2$. The distances from the sides of the triangle are taken in proportion to $\cos^2\theta$ or r^2 .

These charts are particularly suitable for superimposing further information. For example, the chart illustrated may be superimposed with sets of graphs giving the ratio of the smallest and middle side to the largest. The chart for the projection of a cube may be superimposed with graphs denoting the projected angles but actually it is simpler to draw the simple chart for $A + B + C = 360^\circ$ and superimpose charts for angles of projection. This is of particular interest in trimetric projection.

Triangle charts may also be used to give simple products and quotients by taking logarithms. A further use is to denote the proportions of chemical mixtures and compounds.

Theoretically a regular tetrahedron could be used to denote the relation between four variables.

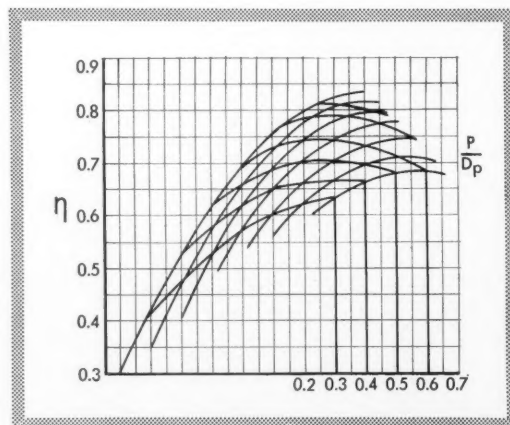


Fig. 4—Example of a simple carpet graph

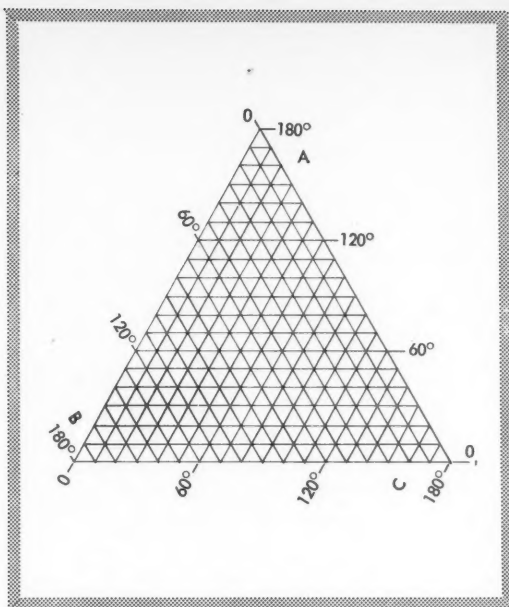


Fig. 5—Triangular chart for angles of triangles

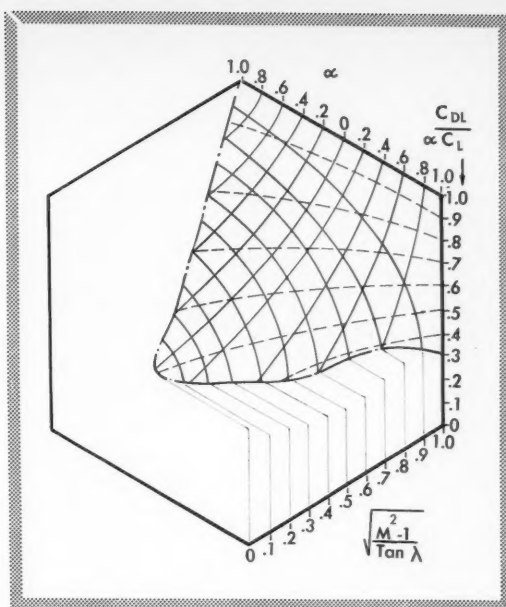


Fig. 6—An isometric carpet graph: drag due to lift

Carpet graphs

Considering a series of graphs representing the relation between three dimensions as in Fig. 3, it frequently happens, as in the example, that the graphs when so plotted are so close together that drawing is difficult and interpolation inaccurate. This difficulty may be overcome by displacing each successive graph by an equal amount as shown in Fig. 4. To facilitate subsequent interpolation and avoid several repetitions of the horizontal scale it is recommended that the vertical lines be inclined to cross each graph as shown, the result being termed a "carpet" graph from its unique appearance. Actually the result is an oblique projection of the three-dimensional surface. In this case it may also be regarded as a dimetric projection. Graphs may also be staggered vertically, this being of particular advantage with round-top curves such as the "hook-curves" of experimental engine data.

It will be realized that graphs may also be staggered both horizontally and vertically but here care must be taken to be clear as to what is being represented. In perusing reports on engine data, it has been observed that virtual three-dimensional models of data are drawn in perspective with the appropriate grids and seem to indicate that they are suitable for interpolation. This is, of course, impossible. On the other hand graphs are sometimes staggered equal amounts horizontally and vertically, the result appearing at first sight to be an isometric projection when actually it is intended for interpolation. In any case compound staggering loses the advantage of simple staggering in that interpolation of the scales becomes difficult,

though it may be simplified as explained in the next section.

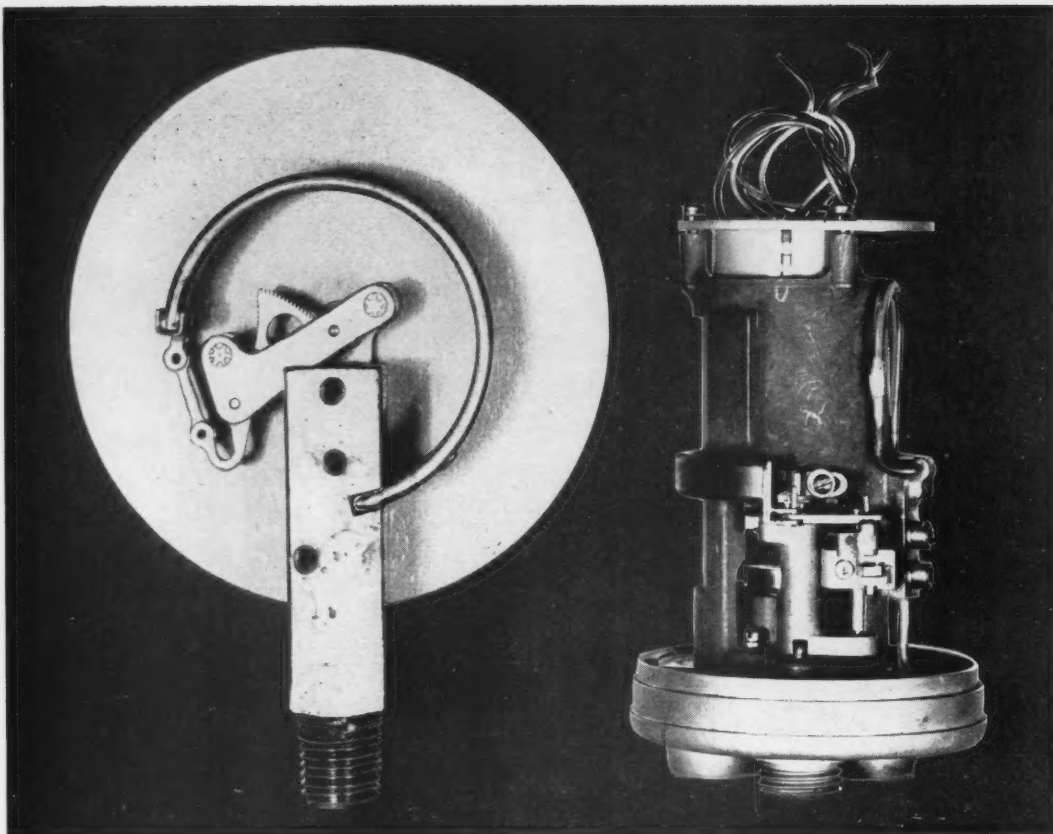
Isometric Carpet

To combine the advantages of the various forms of carpet graph, a method advocated consists as follows, and illustrated in Fig. 6. Procure a sheet of isometric graph paper as used as a trace chart for isometric projections and lay a sheet of tacing paper over. Then draw three axes from a central point to contain three rhombuses which are the isometric projection of three square planes. The numerous small rhombuses making up these planes are then referred to draw in the set of graphs displaced in two isometric directions as shown. The horizontal contours are then interpolated in, the result being an isometric projection of the three dimensional surface, giving equal emphasis to each scale and uniform degree of accuracy for interpolation between each pair. The carpet has both aesthetic effect as a picture of the surface representing the surface and direct use for interpolation.

Lattices

If a series of carpets is drawn for successive values of a fourth variable the result is termed a "lattice". Usually two carpets clear of each other are sufficient, enabling intermediate values to be interpolated. In more advanced work, two pairs of carpets have been used to give particular values at the intersection of joining lines, in effect a lattice nomogram.

★



Latest developments in Bourdon tubes

For all its history, the characteristics can't be predicted accurately

G. Kardos P.Eng.

A Bourdon tube consists essentially of a curved tube of cross-section other than circular which is rigidly secured at one end, while the other end is free. Both ends are sealed except for a capillary tube which permits the application of a pressure on the inside of the Bourdon tube. When a pressure is introduced into the tube, the radius of curvature of the tube and tube angle is increased, and the free end of the tube is displaced in an approximate straight line. The change in radius, tube angle and free end displacement are all directly proportional to the pressure.

By sensing the linear movement of the free end of the tube or change in tube angle the Bourdon tube becomes a pressure sensing device.

The action of the tube may be qualitatively explained as follows (see Fig. 2). When a pressure is applied to the inside of the tube, the walls parallel to the principal axis bulge and the cross-section attempts to become circular. The inside

The Bourdon tube is one of the most widely used elements for detection of pressure. For over 100 years it has measured pressures ranging from $\frac{1}{2}$ to 140,000 psi full scale. In spite of its long history the characteristics of the tube cannot be accurately predicted. In recent years there has been a concentrated effort to rationalize the design of Bourdon tubes. This article draws on these latest developments in an attempt to show the extent to which the Bourdon tubes can be designed rationally and to relate this to normal engineering applied mechanics.

wall tends to move towards the center of curvature *C*, resulting in a compressive stress in this wall along the length of the tube. The outside wall moves away from the center of curvature resulting in a tensile stress in this wall along the length of the

tube. Therefore, with a tube of constant section and curvature, a uniform bending moment about the principal axis of the tube is produced along the length of the tube, which increases the radius of curvature by ΔR . Alternatively it can be stated that internal pressure decreases the radius of curvature of the tube cross section and, in accordance with Gauss' theorem, the product of the curvatures must remain constant, hence the radius of curvature of the tube increases.

Mathematical deviations

Although the qualitative description is straightforward the translation into quantitative results is not so easy, primarily because of the number of simplifications necessary to reduce the parameters to a form in which they can be handled mathematically.

Since the pressure causes a change in radius, a change in tube angle and motion of the free end of the tube, a knowledge of relationship of these changes to one another is desirable so that the theory will be independent of the parameter used for sensing.

The relationship of ΔR (the change in radius), $\Delta \phi$ (change in tube angle) and l (tip movement) is purely a geometric one. Fig. 3 shows a short length of Bourdon tube in which the tube is deflected under pressure, while the arc length of the tube remains constant.

$$R\phi = R_0\phi_0 \text{ (Gauss theorem)}$$

$$R = R_0 + \Delta R \text{ and } \phi = \phi_0 - \Delta \phi$$

$$\frac{R_0 + \Delta R}{R_0} = \frac{\phi_0}{\phi}$$

$$\frac{\Delta R}{R_0} = \frac{\phi_0 - \phi}{\phi}$$

$$\frac{\Delta R}{R_0} = \frac{\Delta \phi}{\phi}$$

Since ΔR is relatively small with respect to R for practical purposes

$$\frac{\Delta R}{R} = \frac{\Delta \phi}{\phi}$$

The co-ordinates of the tube end are

$$x = \frac{R_0\phi_0}{\phi} \sin \phi$$

$$y = \frac{R_0\phi_0}{\phi} (1 - \cos \phi)$$

$$\frac{dx}{d\phi} = \frac{R_0\phi_0}{\phi^2} (\phi \cos \phi - \sin \phi) \dots (1)$$

$$\frac{dy}{d\phi} = \frac{R_0\phi_0}{\phi^2} (\phi \sin \phi + \cos \phi - 1) \dots (2)$$

For very small movements of Bourdon tubes, the differential equation may be written as a difference equation.

$$\frac{\Delta x}{\Delta \phi} = \frac{R_0\phi_0}{\phi^2} (\phi \cos \phi - \sin \phi) \dots (3)$$

$$\frac{\Delta y}{\Delta \phi} = \frac{R_0\phi_0}{\phi^2} (\phi \sin \phi + \cos \phi - 1) \dots (4)$$

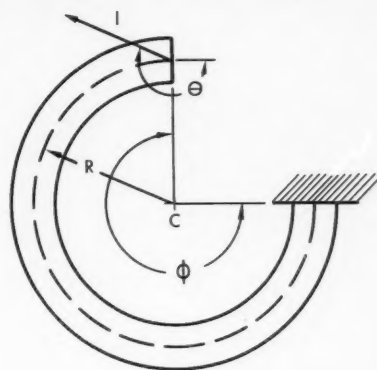


Figure 2

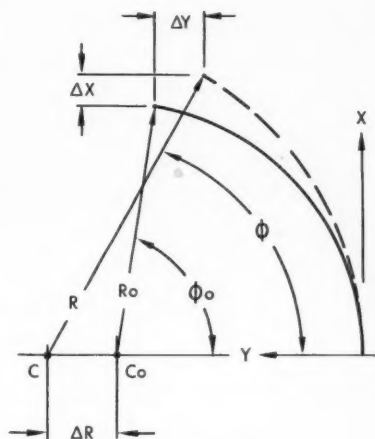


Figure 3

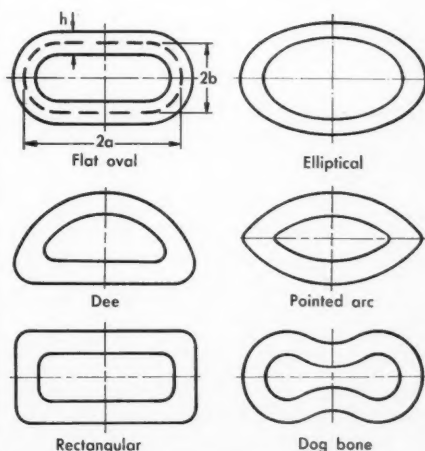


Figure 4

$$\frac{\Delta x}{\Delta R} = \frac{\phi_0}{\phi} (\phi \cos \phi - \sin \phi) \dots \dots (5)$$

$$\frac{\Delta y}{\Delta R} = \frac{\phi_0}{\phi} (\phi \sin \phi + \cos \phi - 1) \dots (6)$$

For small deflections

$$l = \sqrt{\Delta x^2 + \Delta y^2}$$

For normal Bourdon tube $\frac{\Delta \phi}{\phi}$ is small, in the

order of .05 or less, and ϕ_0 may be substituted for ϕ with negligible error.

$$\therefore \frac{l}{\Delta R} = \left[(\phi_0 \cos \phi_0 - \sin \phi_0)^2 + (\phi_0 \sin \phi_0 + \cos \phi_0 - 1)^2 \right]^{\frac{1}{2}} \dots \dots \dots (7)$$

The values of $\frac{l}{\Delta R}$ with respect to tube angle ϕ_0 are plotted in Fig. 4. The Bourdon tube designer tries to design the tube with an included angle ϕ_0 such that he is on the flat part of the curve where errors in tube angle have little effect on the tip travel.

The direction of tip travel θ can be determined from the same equations (5) and (6).

$$\tan \theta = \frac{\Delta x}{\Delta y} = \frac{(\phi_0 \cos \phi_0 - \sin \phi_0)}{(\phi_0 \sin \phi_0 + \cos \phi_0 - 1)}$$

The values of θ for different tube angles is given in Fig. 5.

With the above relationship the designer need only find $\frac{\Delta R}{R}$ with respect to pressure and he can completely determine the motion of his Bourdon tube.

Bourdon tubes may be of any cross section (Fig. 6), but they have two things in common, their

cross sections are non-circular and the major diameter or axis is at right angles to the radius of curvature. Of the cross sections available, the most commonly used are the elliptical, the dee and the flat oval. Once the shape is defined the governing parameters are, the mean major axis "2a", the mean minor axis "2b", and the wall thickness "h".

The quantitative theory for deflection of flat oval Bourdon tubes is still imperfect because of the large numbers of governing parameters. Therefore the designer must depend largely on experience and his art. Published data are available that give a reasonable first approximation and relationships do exist which decrease the amount of experimentation required.

The theory for flat oval Bourdon tubes is the best developed so in the remaining discussion we will limit ourselves to such tubes.

Dr. Wuest, using elastic theory, derives a differential equation for the deflection of tubes which approximate the flat oval shape. His values are the best available as a general theory. These values have been checked against the values for a number of actual tubes with maximum deviation of 50%, and with most values deviating less than 25%. These results are quite satisfactory for first estimates.

Dr. Wuest expresses the tube deflection in the general form.

$$\frac{\Delta R}{R} = \frac{f_1 p}{E} \left(\frac{a}{b} \right) \left(\frac{a}{h} \right)^3$$

p = pressure differential

E = Young's modulus

f_1 = a dimensionless ratio

The values for f_1 are given as a set of curves, Fig. 7, in which f_1 is a function of a dimensionless ratio $\lambda = \frac{Rh}{a^2}$ and the axis ratio $\frac{b}{a}$.

With this the first approximation for a tube design can be made. From these results the first experimental tube can be made and tested.

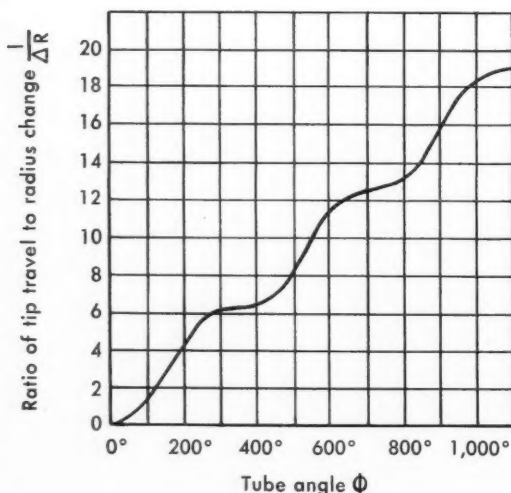


Figure 5

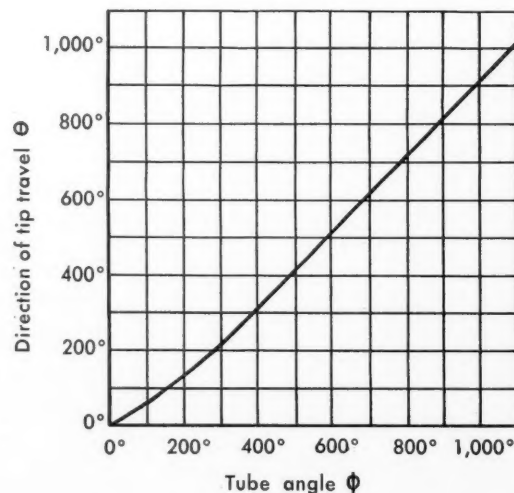


Figure 6

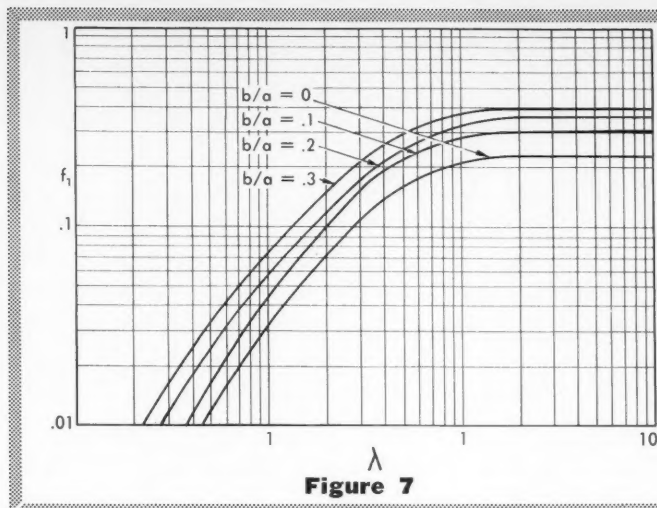


Figure 7

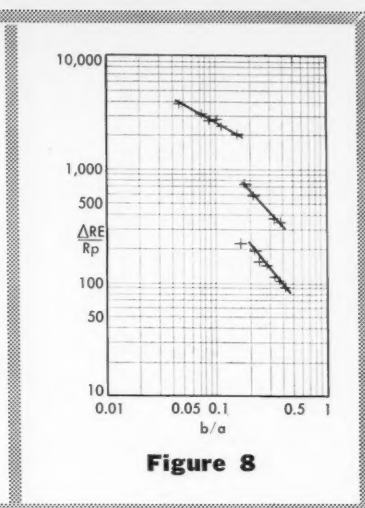


Figure 8

One of the most easily changed parameters is the axis ratio. The author has found that if all other geometric parameters are held constant the deflection can be expressed as a function of the axis ratio as follows:

$$\frac{\Delta RE}{Rp} = \frac{1}{K_1 \left(\frac{b}{a}\right)^{n_1}}$$

Where K_1 and n_1 are constant, dependent on the other geometric parameters.

This equation is a straight line when plotted on log paper. Thus by building approximately three tubes of different axis ratio based on the first approximate design we can plot the results and find the axis ratio that gives the desired deflection.

A plot of three different tube designs is shown in Fig. 8.

It has also been found that when all geometric parameters except the wall thickness are held constant, the deflection can be expressed as a

function of the dimensionless ratio $\lambda = \frac{Rh}{a^2}$

$$\frac{\Delta RE}{Rp} = \frac{1}{K_2(\lambda)^{n_2}}$$

K_2 and n_2 are constants depending on other geometric parameters.

The as received tubing is easily made with constant outside perimeter and different wall thicknesses. If changes in wall thickness are required because of other considerations, stress, corrosion, etc., they can be readily made provided the outside perimeter is held the same.

Thus the tube designer can, by judicious sampling, predict the performance of similar tubes with any wall thickness.

This relationship is shown in Fig. 9 for a particular Bourdon tube design.

With the above relationships the designer can approximate the desired tube, then with a minimum of experimentation, arrive at the final Bourdon tube configuration to meet his requirements. In

addition, the above relationships are important in that they permit him to interpret and make maximum use of any data he has on previous tube designs.

One word about production of Bourdon tubes. The most important factor in producing good Bourdon tubes, once a satisfactory design has been reached, is control. Since so many parameters can have a marked influence on deflection and fatigue, the utmost control must be maintained on all operations. At Aviation Electric Limited, it has been found necessary to control the exact pressures in the forming operations, the number of tubes being heat treated in each batch and, not only the heat treating time for age hardening alloys, but also the point in the temperature swing at which the treatment is started. ★

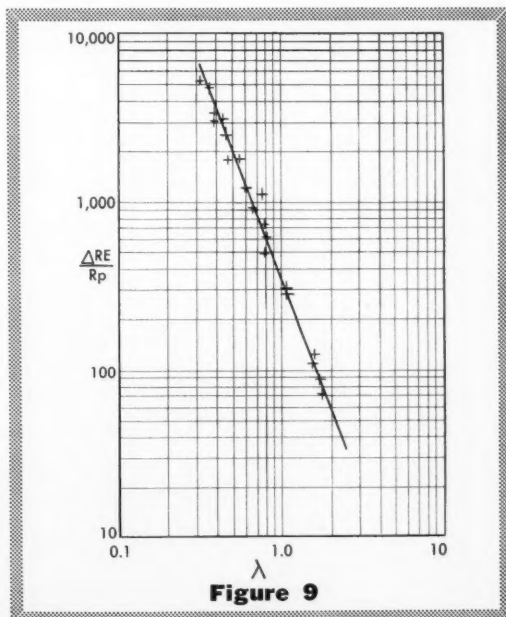


Figure 9

"Blow-up" tubing has 101 applications

This light-wall tubing brings a new concept of flexibility to engineering. You'll buy it like ribbon — merely inflate it on the job

Experimental production will be started this fall of light-wall seamless metal tubing that can be shipped in ribbon form and inflated at the point of use. The new material—to be known as STRUBING (strip tubing)—holds promise of major innovations in industries as diverse as construction, electric power distribution, communications, rockets and missiles, farming, packaging, chemical and general manufacturing.

Strubing offers two major advantages. First, point-of-use inflatability makes it possible to ship thin-wall tubing economically, since only the tube "walls" are shipped and not the "hole". Second, the process used in making strubing, technically classified as cold rolling, provides an economical means of producing thin-wall tubing of materials and in thicknesses either unavailable today or available only at a prohibitive cost.

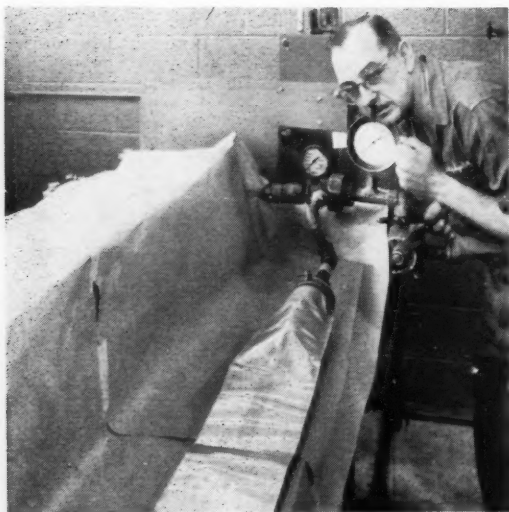
Field inflatability might make it possible, for instance, to ship the entire ductwork for the heating system for a 7-room house in a box the size of an orange crate

instead of in truck loads. The strubing ribbon might be strung through the house and then inflated right in place—for a major saving in time and effort over conventional installation of ductwork. Other potential uses for strubing in building and house construction include downspouts and electrical conduit.

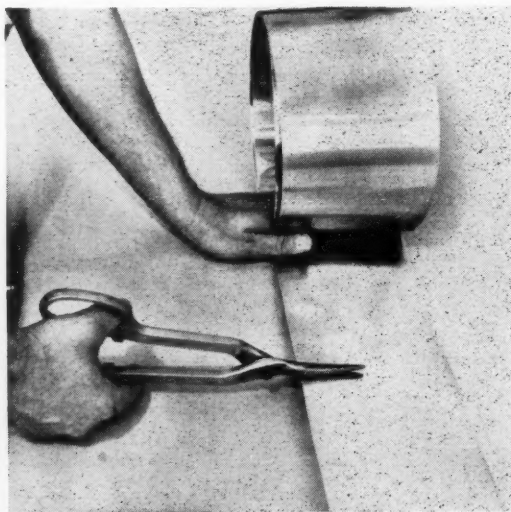
Because of its availability in long lengths and very light walls, strubing could simplify the problem of sheathing power distribution and communications cable.

Lining by Inflation

"Lining by inflation" techniques might be used to construct low-cost, corrosion-resistant piping and vessels for the chemical, petrochemical, and process industries. This would be done by combining strubing made of a corrosion-resistant material such as tantalum and ordinary steel. Tantalum strubing ribbon might, for example, be inserted in a pipe or tank and inflated to form an inner liner.



Strip of Strubing gets the necessary inflation treatment.



Cut off what you need. Metal shears are adequate for job.

Engineers believe that this technique could also be used for repairing sewer and water mains that develop leaks. Rather than having to rip up a street or other ground surface to remove and replace sections of pipe, strubing of some suitable material could be inserted and inflated to act as a protective "inner tube".

On major construction projects, strubing would fill the need for temporary field piping to transport water, fuel, and compressed air to various field installations. Truck-mounted strubing reels would simply unwind the necessary amount of tubing, the strips would be inflated and coupled ready for use.

Strubing should provide substantial savings in shipping, storing, and handling in manufacturing plants using thin-wall tubing. Shipped in compact rolls or reels, the material would be used right on the line by simply unreeling a required length, expanding and cutting to length. The fact that it comes in a continuous ribbon makes strubing particularly suitable to continuous manufacturing operations. Typical uses for small-diameter strubing might be for instrument lines, automotive tubing such as radiator, overflow and thermostatic control lines, or for making the tubes for ball-point pens or mechanical lead pencils.

Rocket and missile use

Strubing made of special metals such as stainless steel alloys, zirconium, titanium, tantalum, or columbium might prove to be of critical importance to the rocket and missile industry. The product lends itself to the manufacture of light-wall, large-diameter, seamless rocket and missile bodies. Smaller diameter strubing would be useful for fuel lines handling the highly-corrosive liquids powering today's rockets.

Packaging applications

Strubing in metal-foil thickness holds promise as a packaging material for frozen foods, for toothpaste or materials of similar consistency, or simply as a covering for food for reheating. It would be easier to insert a chicken in a length of strubing and crimp the ends than it would be to wrap a foil sheet around it. Somewhat heavier-walled strubing could be used by the canning industry. The advantage over conventional

cans is the fact that the tube is seamless, whereas a can now has a seam down the side. In addition, the long length availability of the product is ideal for continuous canning lines.

Inflation Techniques

The methods and equipment to be used for inflating strubing will probably vary with the application of the material and its dimensions. Engineers have used hydraulic pressure, air pressure, and mechanical means to "inflate" the tubes during experimental development work. The thinner the wall thickness, obviously, the lower the pressure required to inflate. In some sizes, strubing can be inflated simply by using tap water pressure.

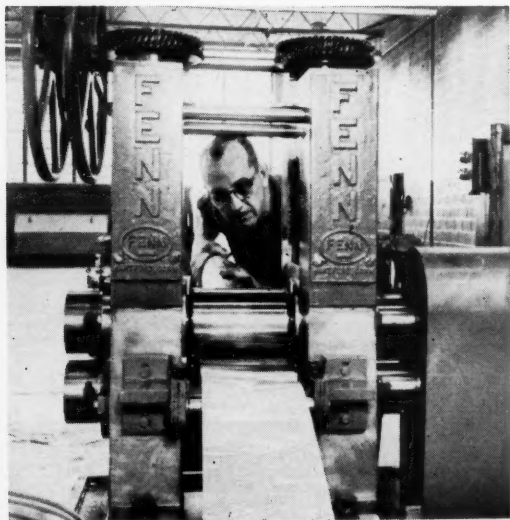
Strubing can be made in sizes ranging from smaller than the lead in a pencil to a pipe large enough for a man to walk through. It can be made as thin walled as household metal foil to as thick walled as conventional pipe. It will be possible to ship strubing in coil lengths of as much as 15,000 feet.

Method of Manufacture

Techniques involved in making strubing are reported to be basically very simple. The first step is to make a simple hollow shape by conventional techniques. It is then passed through a rolling mill where it is flattened into ribbon form. The rolling process is such that it elongates the original tube by making it thinner without changing the inside tube diameter. The more passes through the rolls, the thinner the strubing. The diameter is limited only by the size of the starting piece. And the size of the starting piece is limited only by the capacity of the rolling mill used.

Inherent in the product produced by the rolling process is a pair of fins or ribs on the outside. These fins provide added stiffness to thin-walled tube. If desirable, the fins can be removed as the strubing is being formed.

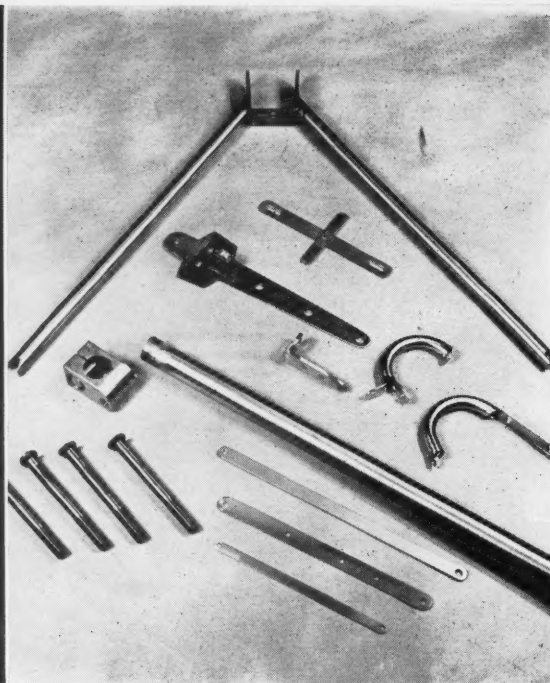
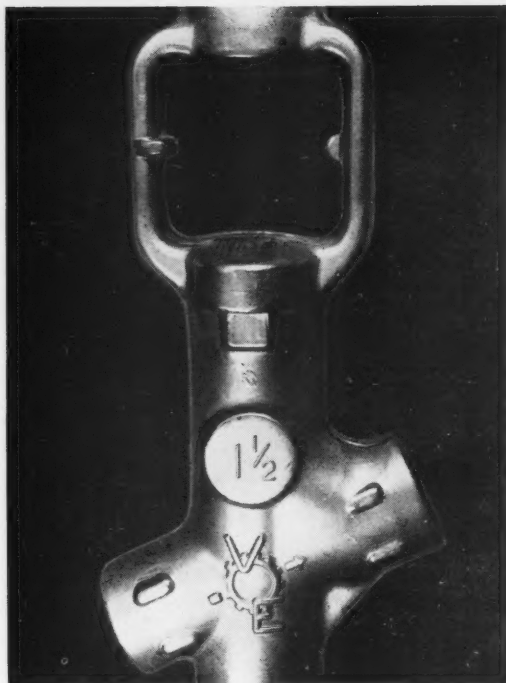
The manufacturing process for making strubing is based on patents and patent applications held by inventor Howard A. Fromson of New York City. Calumet & Hecla Inc. has exclusive United States and Canadian rights to the Fromson patents. ★



Base tube gets converted to "ribbon" in rolling mill.



At left is starting base tube; final Strubing at right.



Forged and cleaned globe valve (above) was drop forged. Sailboat fittings were made from commercially pure titanium.

Titanium: metal with an exciting future

An outstanding metal, titanium combines the tensile strength of alloy steel with just 57% of its weight. Its chief properties are discussed here.

J. M. Wentzell, P.Eng.

Exclusive DE Feature

Few metals have excited the imagination of the engineer as much as titanium. It represents the closest approximation to the ideal aircraft metal, combining the tensile and shear strength of alloy steel with only 57% of its weight. It is so outstanding that all men who design or work with metal will want to consider its application in every assignment they tackle.

While one of the earth's most abundant mineral elements, titanium is costly to recover and process. The basic ore is first reduced to sponge, which is then converted to ingot form. Ingots are then fabricated into basic mill shapes—rod, bar, billets, sheet, plate, using mill equipment commonly used for steel.

Titanium is sold in "commercially pure" as well as alloy form. Fasteners and components are now serving a wide field of industrial applications, while the use in aircraft becomes increasingly important in this age of jets, missiles and satellites.

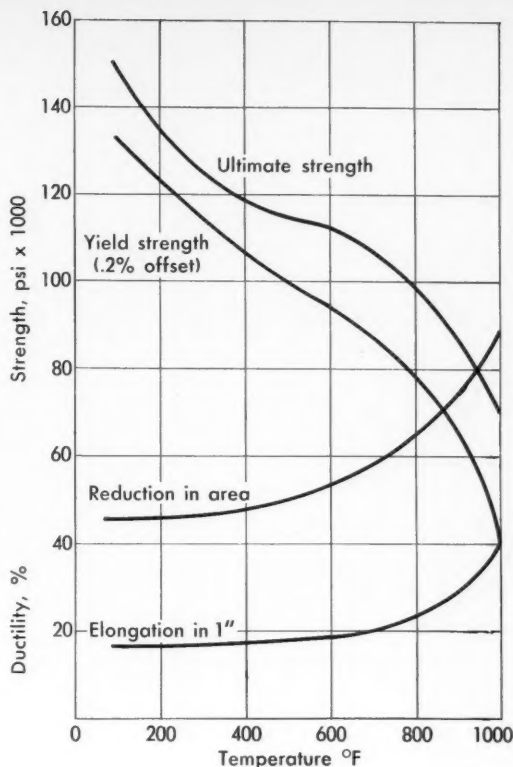
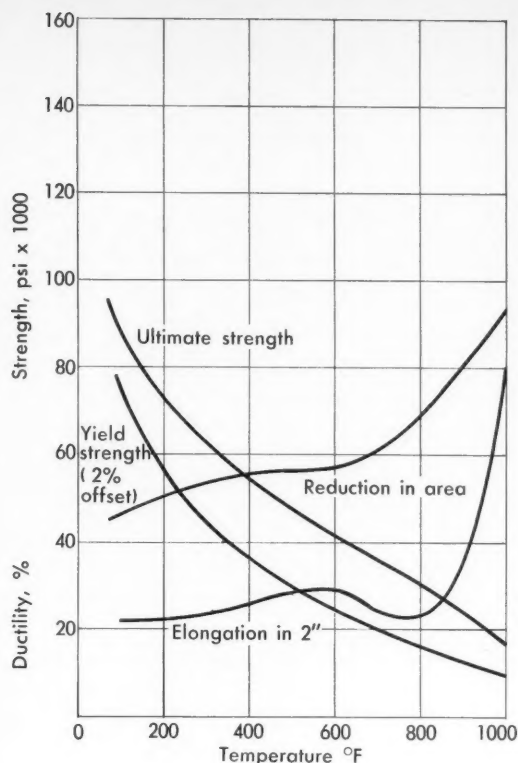
Mr. Wentzell is the Technical Service Director of Atlas Titanium Limited, at their head office in Welland, Ont.

Titanium has two allotropes: alpha titanium, which has a hexagonal close packed crystalline structure and beta titanium, which is body centred cubic. The alpha phase is stable from room temperature up to approximately 1625 F, whereas beta is stable from 1625 F up to the melting point of about 3130 F.

Most alloys are used in the alpha-beta annealed state. In this condition the alpha phase is comparatively soft and ductile and the beta phase is somewhat harder and less ductile at room temperature. In contrast to this, alpha is stronger than beta at hot working temperature. Control of beta to alpha transformation enables titanium alloys to be hardened by heat treatment.

Most alloying additions to titanium tend to stabilize the beta phase (i.e. lower the transformation temperature). These include iron, chromium, manganese, molybdenum, and vanadium. Aluminum tends to stabilize the alpha phase (i.e. raise the transformation temperature). Some elements such as tin and zirconium behave as neutral solutes in titanium (i.e. neither raise nor lower the transformation temperature).

The beta stabilizing elements promote heat-treatability of titanium; however, some beta stabilizers like iron



and chromium form brittle compounds under certain conditions of compositions and temperatures.

The alpha stabilizing elements such as aluminum strengthen the alloy at elevated temperatures but these alloys cannot be heat-treated to high strengths at room temperature.

Combinations of alpha and beta stabilizing elements therefore are used in the design of titanium base alloys for specific applications.

Corrosion properties

Outstanding resistance to many types of corrosive media, including some of the most troublesome industrial chemicals, is one of titanium's most attractive characteristics. It is excellent in resisting corrosion by nitric acid, moist chlorine, solutions of chlorine, chlorinated organic compounds, and inorganic chloride solutions. Its resistance to corrosive attack by sea water and by most chloride salt solutions is unchallenged by other structural metals.

Additional advantages of titanium are its non-susceptibility to impingement, and its resistance to pitting attack. Also the corrosion resistance of a titanium weldment is essentially the same as that of the parent metal.

galvanic corrosion

In general, no serious corrosion problems will result from coupling titanium to 18-8 type stainless steels, nickel Monel, Inconel, or Cupronickel alloys. There may or may not be problems, depending on specific

environmental factors, with copper, brass, tin, lead, and steel; while magnesium, aluminum, iron, and cadmium would be expected to show significant accelerated attack when coupled to titanium in electrolytic media.

environmental effects

There is no significant corrosive attack on titanium when exposed to marine and urban atmospheres, salt water spray, brackish river water, and in low or high velocity sea water. Fouling organisms which accelerate corrosion on other passive type metals have no effect on titanium. In fact, titanium's corrosion resistance is comparable to that of the platinum group of metals.

resistance to chemicals

Titanium exhibits resistance to corrosive attack by many inorganic and organic chemicals. Perhaps the most phenomenal behavior is its resistance to attack by hot chloride solutions which severely attack most metals. In combinations of acids that do attack titanium, the addition of even small amounts of an oxidizing acid such as nitric or salts such as copper sulfate inhibits corrosive attack.

Machining

Production results have indicated that commercially pure titanium machines similarly to 18-8 stainless steel. The alloy grades machine somewhat harder but do not approach the difficult-to-machine high temperature alloys.

continued ►

turning

Commercially pure and alloyed titanium can be turned with little difficulty. Carbide tools are the most satisfactory for turning titanium. Cast alloy tools may be used when carbide is not available and when the cheaper high speed steels are not satisfactory.

milling

The milling of titanium is a more difficult operation than that of turning. The cutter mills only part of each revolution. During the portion of the revolution that each tooth does not cut, the titanium chip remains tightly welded to the tooth's edge.

This problem can be alleviated to a great extent by employing climb, instead of conventional, milling. In this type of milling, the cutter is in contact with the thinnest portion of the chip as it leaves the cut.

For slab milling the work should move in the same direction as the cutting teeth; and for face milling the teeth should emerge from the cut in the same direction as the work is fed.

In milling titanium the cutting edge usually fails because of chipping, thus the results with carbide tools are often less satisfactory than with cast-alloy tools. An increase in cutting speeds of 20-30%, possible with carbide tools over cast-alloy tools, does not always compensate for the additional tool grinding costs. Consequently, it is advisable to try both cast-alloy and carbide tools to determine the better of the two for each milling job. The use of a water base coolant is recommended.

drilling

Successful drilling can be accomplished with ordinary high speed steel drills. One of the most important factors in drilling titanium is the length of the unsupported section of the drill. This portion of the drill should be no longer than necessary to drill the required depth of hole and still allow the chips to flow unhampered through the flutes and out of the hole.

tapping

Tapping titanium is one of the more difficult machining operations. Most of the success in tapping has been with a 65% thread.

Chip removal is one of the serious problems in tapping. However, in tapping through holes, this problem is simplified by using a gun-type tap; the chips are then pushed ahead of the tap. Another problem is the smear of titanium on the land of the tap, thereby resulting in the tap freezing or binding in the hole. An active cutting oil such as a sulfurized and chlorinated oil is helpful in avoiding this.

grinding

A proper choice of grinding fluid, abrasive wheel and low wheel speeds can expedite this form of shaping titanium. The procedure recommended is to use considerably lower wheel speeds than in conventional grinding of steels. Indications are that titanium can be ground more easily than high speed steels.

Fabrication

Forming sheet material is accomplished by four basic methods; hydropress, brake, stretch forming and drop hammer. In forming a titanium part, the first step is preparation of the blank. This operation is very similar to that used for 18-8 stainless steel. Shearing, die blanking, nibbling and sawing are all satisfactory.

For the best results, it is particularly important that any burr be removed from the titanium blank edge before forming. This operation is necessary because of the relative notch sensitivity of titanium. The deburring operation actually should produce a round polished edge.

hydraulic press forming

Rubber pad hydropress forming can be accomplished either hot or cold depending on the type tooling employed and the press pressures used. This type of forming is used on parts that are predominantly flat with flanges, beads and lightening holes

power brake forming

Brake forming is used to form angles, Z-sections, hat sections, and channels. In practice, the sheet metal blank is placed over a trough die and the angle formed by forcing the sheet into the trough with a male die. The minimum bend radius for brake forming of commercially pure titanium should not be less than 3T. The best results are obtained by brake forming between 400 to 600 F.

stretch forming

Stretch forming has been used on titanium primarily to bend angles, hat sections, Z-sections and channels and to form skins. This type of forming is accomplished by gripping the section to be formed in knurled jaws, loading until plastic deformation begins, then wrapping the part around a male die. Loading of the part or sheet until plastic deformation begins and wrapping around the die should be done at a very slow rate. Spring back is equivalent to that of one quarter hard 18-8 stainless steel. All blanks for stretch forming should have the edges polished to remove any notch effects.

drop hammer forming

Drop hammer forming has been accomplished both at room and at elevated temperatures. In drop hammer forming, the best results have been obtained by warming the female die to 200-300 F to remove the chill and heating the blank to 800 to 1000 F for 10 to 15 minutes. The part is then struck and set in the die. In most instances, a finished part requiring no hand work is obtained.

heat treatment

The only heat treatment necessary on commercially pure titanium is a stress relief operation. The received material is in the annealed condition so it is in its most workable form. After cold forming operations are complete, a stress relief treatment is necessary to relieve residual stresses imposed during forming. Stress relieving may be accomplished by heating at 700 to

TABLE I
**Mechanical Properties of
Annealed Titanium and Its Alloys**

	Form	Ultimate Tensile Strength PSI	Yield Strength PSI	% Elongation*
Commercially pure titanium				
MST 40	Sheet & Bar	70,000	50,000	25
MST 55	Sheet & Bar	85,000	65,000	23
MST 70	Sheet & Bar	100,000	80,000	20
TITANIUM ALLOYS				
MST 3A1-2.5V	Strip	83,000	80,000	21.6
MST 6A1-4V				
Annealed	Bar	140,000	130,000	15
Age hardened (1)	Bar	165,000	155,000	12
Age hardened (2)	Bar	180,000	165,000	10
Annealed	Sheet	140,000	125,000	12
MST 3A1-5Cr	Bar	155,000	145,000	13
MST 4A1-4Mn	Bar	150,000	140,000	14
MST 5A1-2.5Sn	Sheet & Bar	115,000	110,000	10
MST 2.5A1-16V (3)	Sheet	170,000	147,000	4 min.
MST 7A1-4Mo	Bar	145,000	135,000	10 min.
MST 431	Sheet	170,000	147,000	3 min.
MST 821	Bar	125,000	115,000	10 min.
MST 881	Bar	145,000	125,000	16
MST 8Mn	Sheet	120,000	110,000	16

(1) 1650°F—1 hour—WQ; 1100°F—2 hours—AC

(2) 1700°F—1 hour—WQ; 1000°F—8 hours—AC

(3) 1400°F—½ hour—WQ; 960°F—4 hours—AC

WQ—Water Quench

AC—Air Cool

*Values for 1" on bar and 2" on sheet

1000 F for 15 to 20 minutes. As an aid in cold forming, it usually is necessary to stress relieve where more than one stage of fabrication is involved. For example, the part should be stress relieved after brake forming prior to stretching and also between room temperature hydropress forming stages.

Welding

Commercially pure titanium and some titanium alloys can be welded with good results. However, proper precautions must be taken during welding to protect the weld area from contamination by the surrounding atmosphere.

Molten titanium is extremely reactive with nitrogen, oxygen, and hydrogen, and it will dissolve large quantities of these gases. These contaminating gases embrittle the titanium, so that ductile welds cannot be produced by oxyacetylene welding and other forms of welding using active gases, electrode coatings, or fluxes.

Satisfactory methods for welding titanium include

inert-gas shielded arc welding, spot, seam, and flash welding. These methods include provision for shielding the molten weld metals and adjacent heated zones from active gases that would contaminate the metal.

The two major processes for arc welding are the nonconsumable electrode (tungsten arc) and the consumable electrode (titanium or titanium alloy wire) methods. Both the tungsten arc and consumable electrode methods are adaptable to manual or automatic type arc welding equipment.

Spot, seam, and flash welding procedures for titanium are similar to those used on other metals. Special shielding is usually not required because of the short welding times and proximity of the surfaces being joined. The welding current and time have the greatest effect on the quality of spot and seam welds. With variations in these conditions, the diameter, strength, penetration, and indentation of the welds change appreciably. For all applications, welding conditions should be established considering the thickness being welded and the properties desired. ★



Fig. 1—Enamel, nickel used in circa 1920 stove.



Fig. 2—New version of gas stoves helped boost stove, gas sales.

Role of consulting engineers in design

A leading consultant states the case in no uncertain terms. He says the use of consultants brings a fresh approach to specific problems

John Shotwell, Ph.D., P.Eng.

Exclusive DE Feature

Management has become acutely aware that consulting engineering is a profession which demands that its participants have tremendous versatility and a vast amount of constantly accruing knowledge. This awareness has resulted in a growing use of consulting engineers on special design problems where they can apply the wealth of knowledge and experience gained through contacts with problems in many fields and plants to the solution of problems in another. The consultants' intimate acquaintance with the methods, processes and products in many plants located in several regions gives them a knowledge which the ordinary plant engineer could only assimilate by long service with each of several firms functioning in different fields.

Corporation management feels that the experienced consulting engineer will bring a fresh approach to the problem, unrestricted by the confining traditions and limitations of a particular plant or industry. In addition, management desires to utilize the technical ability of engineers who can take the utmost advantage of scientific advances in technology and methods.

Consultant's Approach

The consultant, upon being retained, co-ordinates his staff with that of the client so that the two will function as a team and not go off on diverse tangents.

The consulting engineers need the plant staff and the plant engineers need the consulting engineers' wider experience and fresh outlook. They may also need the continuity of effort which the retention of a consultant will bring to the problem.

The consultant normally will assign a senior member of the firm as project manager, who will discuss the problem in detail with the client's management and carefully delineate the objectives and scope of the

Consultants in design assist manufacturers and others where the client needs help of a broad, yet detailed character — and especially where the technical information must cover several fields and industries. Examples of consultant work quoted by the author include the redesign of armored tanks and shell casings, design of the Seaway turbines and consumer goods.

project and the time available. The project manager will in turn assign the project to a project engineer, suggesting to him what appear to be the most desirable and feasible methods for attacking the problem but, at the same time, instructing him to use his own judgment. The project engineer, in turn, makes an exhaustive survey of pertinent facets of the problem (technical, patent, manufacturing and if needed, marketing), after which he and his team carefully analyze the data and decide upon the best approach.

The above is spelled out in some detail and is shown in figs 3 and 4. This is the procedure normally used by the larger firms. Smaller firms use the same methods, although they may consolidate the functions of two or more positions in the person of one man. Also, some larger corporation with several plants and divisions have their own subsidiary consulting firm or central engineering and research groups which act as consultants to the operating divisions. These organizations generally carry out their mission along the lines described in this article.

In order to achieve the maximum results, it is essential that the consulting group integrate their operations with that of the client's staff, (unless specifically instructed not to do so.) There are several reasons for this, including the need for cooperation in gauging the

plant's capabilities for manufacturing the new product and also in the implementation of the consultants' report. It is extremely likely that the new designs will require the reorganization of the production lines, the purchase of new equipment and the procurement of additional personnel and all these points must be discussed with the plant staff and have their full concurrence. The following are some examples of how this system works.

Redesign of tanks

During 1940-1941, the Montreal Locomotive Works and the American Locomotive Company faced untenable delays in production of tanks for the Allies. They retained the services of a consulting engineer who possessed wide experience in the construction of armored ships, the fabrication of super high pressure vessels and the production of heavy equipment. He had established a reputation of obtaining the full cooperation of plant staffs and the working force and in improving production schedules in these fields.

He investigated the problem and discovered that the design of the turrets and hulls called for rivetted construction, with close tolerances in cutting the heavy armor plates to size. Bending them into shape was a

Organization of consulting design engineering firm

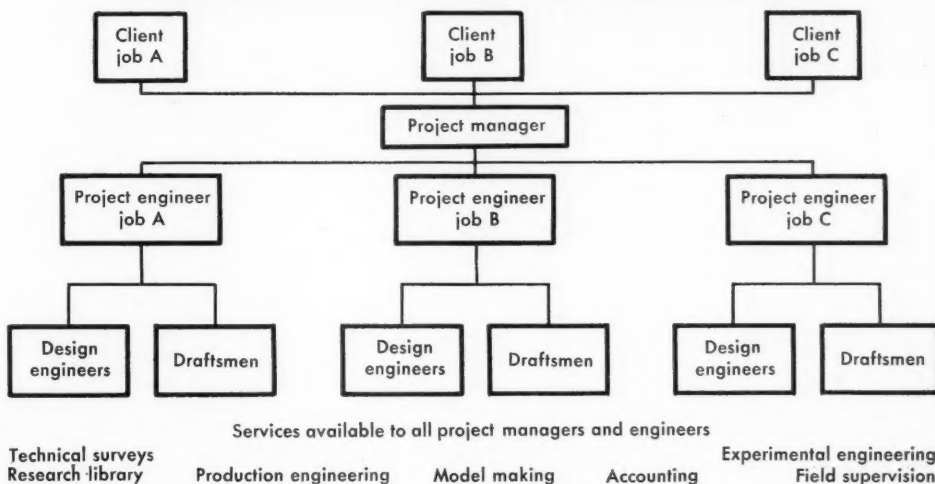


Fig 3

Relationship of consultant and client staffs

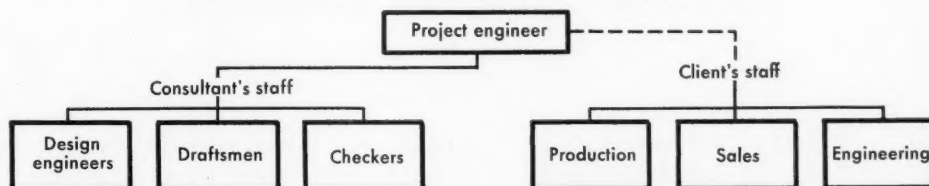


Fig 4

major factor in the delays and poor schedules. He also found that the foundry departments had additional capacity for large castings and that this capacity could be readily increased.

Then, with the assistance and full cooperation of the Defence Production Department, he redesigned the tank hulls and turrets so that each could be cast in one piece with the armor integral in the casting. The new design eliminated most of the forming and rivetting and increased the production rates to meet the most demanding schedules set by the authorities. The new designs also improved the tanks and reduced the danger of casualties to the crews, through the elimination of flying rivet heads sheared off by the impact of shells on the armor.

The Australian War Production Board ran into problems in maintaining the desired schedules in the production of deep drawn shell casings. They employed a group of consultants under Sir Herbert Jepp who found that much of the lost time and poor production resulted from the time required for stress relieving and annealing between draws. The casing design and production line were based upon peacetime requirements and did not lend themselves to the greatly increased demands of wartime.

The consultants studied the problem using blanks consisting of layers of multi colored wax. They ran these through the dies and rapidly discovered where the trouble lay. This information assisted them in redesigning the dies and the production methods so that they eliminated several steps and greatly increased the production rate.

Seaway turbine design

The Canadian turbine manufacturers bidding on the turbines for the Robert H. Saunders Station of the Ontario Hydro Electric Commission's St. Lawrence River Power Project used consultants (or central research and development departments) to design the turbines and turbine settings. The original concept of this international power project visualized the two sections using equal volumes of water and producing equal quantities of power. To this end, the consulting engineers to the two authorities specified the head of water to be used, the volume for each turbine, the power developed and that the guaranteed turbine efficiency must be 90%.

At this point the two specifications differed. The American specification stated that all bids would be equated on the basis of a 90% efficiency; that any failing to guarantee this efficiency would be penalized accordingly and that any guaranteeing more than this would be considered equal and would be equated on the total cost of construction. The Ontario Hydro, on the other hand, specified that they wanted the most efficient plant and that all bids would be equated on the basis of the guaranteed efficiency and power produced.

This placed a decided premium on improved designs for the Canadian bidders, and they set out to take advantage of it. They called in consulting engineers to carry out extensive experimental work with scale models in hydraulics or fluid mechanics laboratories and during these experiments redesigned the turbines, cages, casings, head races, draft tubes and settings. The winning design guaranteed an efficiency of 92.5% and

was expected to exceed this after the turbines were installed.

Consumer goods design

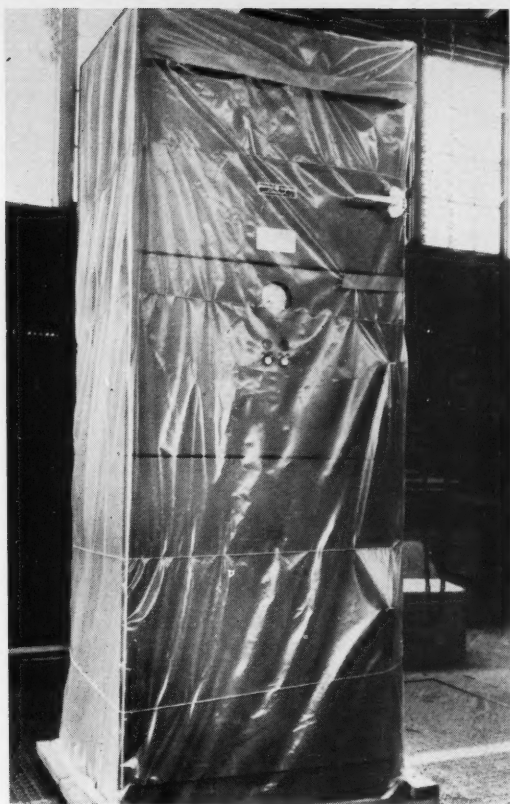
The gas stove manufacturers decided that something must be done and retained consulting engineers to redesign the burners and the ovens. The new designs have top burners which gave even distribution of heat to saucepans and skillets and which eliminate much of the dirt through more complete combustion at all temperatures. The ovens are fully insulated and possess efficient thermostats and in some cases times which start the ovens at a predetermined time, keep the temperature at a constant level for a given period then alter it for a further period and finally cut off the heat. These improvements and the generally cheaper fuel reversed the trend and brought back the sale of gas stoves and gas for household cooking. (Figs. 1 and 2.)

Rounthwaite and Fairfield, the architects who designed the new theatre for the Stratford Shakespearean Festival, conceived the design of the general structure including the roof, auditorium dome, galleries, walls and the columns. They considered various methods of construction, including steel framing, precast concrete, reinforced concrete and masonry, after sketching the preliminary designs. They then retained consulting engineers to review all the structural design and to make a complete stress analysis of the building. The consulting engineers recommended the use of reinforced concrete below the special frame bearing the roof and auditorium dome and designed a new and unique type of frame to carry these loads. This new frame readily fitted into the over-all design of the building and while it was easily fabricated and erected it made the whole structure more stable and flexible in use.

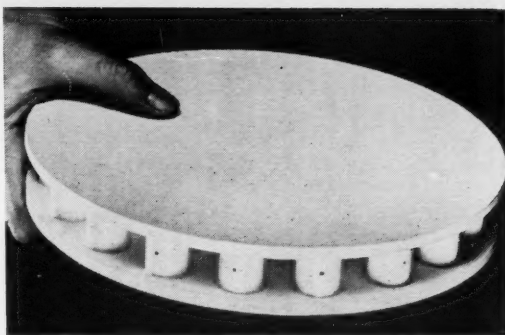
A manufacturer of aircraft heaters retained a consulting engineer to examine his product and those of his competitors and then design something that was more efficient, lighter in weight, and would not allow the exhaust fumes to enter the heated air to the cabins. He also wanted something that would be as cheap or cheaper to build.

The consulting engineer examined the existing heaters and found that they consisted of a burner inside a steel tube on which fins had been pressed and all enclosed in a casing through which the air to the cabin flowed at right angles to the axis of the heating tube. The thermal efficiency of the units were low due to the short time of contact between the fins and the heating air and also because of the low heat transfer rate between the flame and hot gases and the fins, (hot gas to steel wall through a mechanical joint to the fins). He redesigned the unit using stainless steel tubing with a muff of aluminum cast onto it in such a manner as to obtain a positive bond between the two metals and then milled fins out of the aluminum muffs. By using welded U-tubes he obtained three passes of the hot gases across the current of air and increased the contact efficiency while the bonded aluminum fins had greater heat transfer rates. The new design was more compact, cheaper to build and more efficient and at the same time reduced the danger of fire due to cracking and permitting the flames to enter the heating air.

The above examples indicate a few of the fields in which consulting engineers have played effective roles in design problems. They assist manufacturers and others in design where the client needs help of a broad, yet detailed, character and especially where this technical information must of necessity cover several fields and several industries. ★

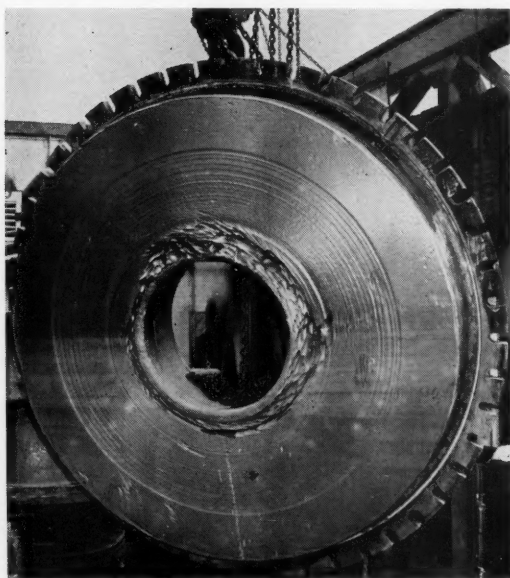


200—Now that handlers can see critical areas of this unit, it doesn't get damaged. Polyethylene film is wrap.

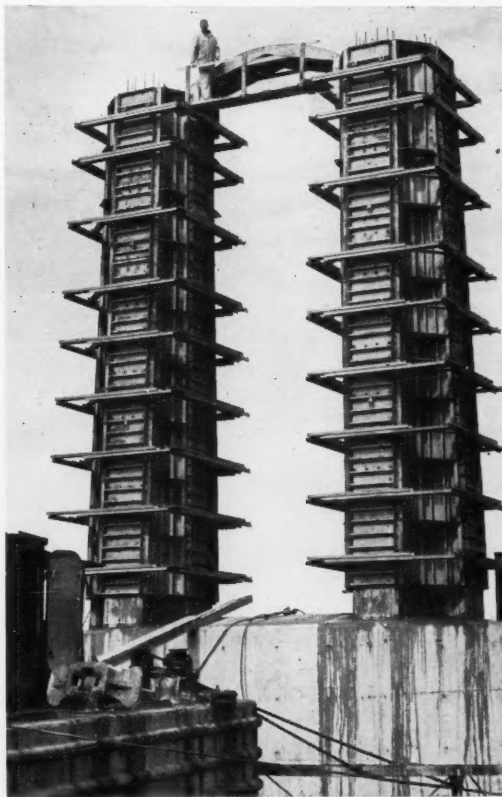


202 — Mirror blanks for outer space telescopes are in lightweight sandwich construction glass ceramic.

Design News in Pictures



201—Tough steel for a tough job. This dredge pump lining is over 10-ft. in dia.; made of Lukens T-1 steel.



203—Despite large dimensions, no tie rods were used to concrete these pier columns at Ogdensburg, N.Y. bridge.



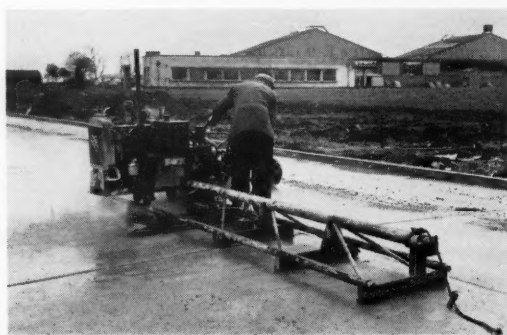
204—Gas storage spheres made of .73-in thick shell plates. Over 110-ft. in diameter, the vessels are in Tokyo.



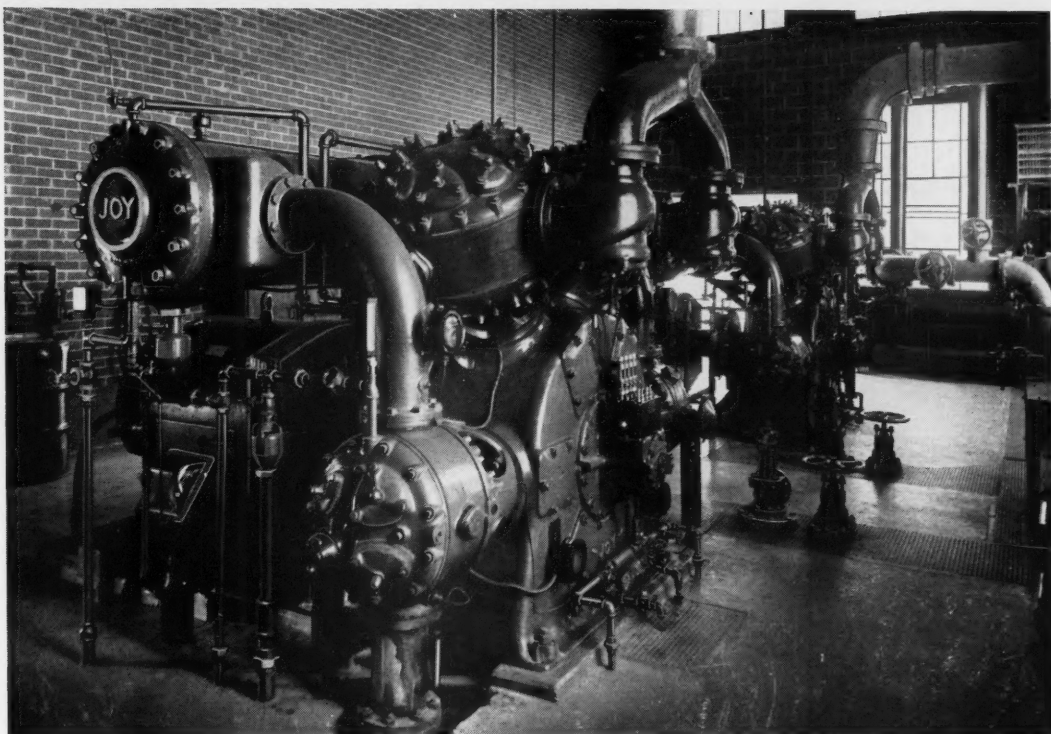
205—Molded lenses of butyrate plastic are installed on electric distress marker signals.



206 — Electrically heated plastic forming and repair tool is used in laying up fibreglas cloth over molds.



207—Machine makes possible cutting of 100% straight lines in concrete roads. It cuts up to 1½-in. joints.



Two 300 hp compressors are shown in this typical pipe installation where special design had to be undertaken.

Here's how to calculate pipe sizes

By using this method, engineers also get a future design flexibility

When planning a compressed air pipe installation, the maximum air quantities which will be used at the working points should first be calculated. Furthermore, allowance should always be made for possible future extension — particularly in the case of main lines — as the additional initial cost of an oversize pipeline is small compared with the cost of subsequent modifications or replacements should the original system prove insufficient.

For stationary plants in workshops and shipyards, the layout should be so proportioned that the pressure drop from the compressor to the most distant points served by the pipeline does not exceed 1.5 psi. In some instances, such as in mines with long pipelines and in temporary installations, it is more economical to save on piping costs and accept a greater pressure drop. This, however, should never exceed 7 psi.

The diagram on the data page can be used to calculate the sizes of the pipes required for a particular installation. For example, if the air consumption at a pressure of 100 psi at the point of use is 150 cfm and the distance from the compressor point is 500 ft., the required pipe sizes can be calculated as follows: Move horizontally across the diagram from the air flow figure of 150 cfm to the vertical line representing the working pressure of 100 psi. From this point draw a line parallel to the inclined auxiliary lines to intersect the heavy vertical line. From this point proceed horizontally to the

vertical line representing the pipe length of 500 ft. Then draw a line through this last intersection parallel to the inclined auxiliary lines. The intersection of this line with the horizontal line representing the pipe size (or the vertical line representing the pressure drop) give the pressure drop for a given pipe size (or the pipe size for a given pressure drop).

In the assumed example a pipe size of 2 in. gives a pressure drop of 1 psi. This pipe size is suitable for a stationary installation.

The diagram shows that the pressure drop increases to 2.25 psi or 4 psi if the pipe bore is reduced to 1.75

How can one ensure that a newly installed compressor plant will not literally "run out of air" and require costly modifications and expansion after it has been in operation for only a few years? This can happen if proper attention is not paid to the calculation of pipe sizes during the planning stage. This article deals with this important but easily overlooked consideration. Although the calculations outlined in this article can be made by means of a simple slide-rule, we consider the problem of sufficient importance to require a detailed explanation.

in. or 1.5 in. respectively. To reduce the cost of the piping, 1.75-in. pipes can be used for a temporary installation without incurring too great a pressure drop. A pipe diameter of 1.5 in. can be used if it is already available. However, if a new pipeline has to be installed the minimum diameter should be 1.75 in. The diagram can, of course, be used to calculate any one quantity providing the other two are known — for example, to compute the maximum air flow through a given pipeline at a given maximum pressure drop.

All valves, pipe bends, etc., will also produce a pressure drop in the pipeline. If there are only a few such fittings their small frictional resistance may be ignored when planning a compressed air pipe installation. However, if the system has many sharp bends and valves their resistance must be considered in the design.

Equivalent pipe length means the length of straight pipe which involves the same pressure drop as these fittings. In calculating a pipe system by the diagram the pipe length's equivalent to all fittings should be added to the length of the piping.

Example of calculation

We shall consider the case of a simple pipe system (as in Fig. 2), where K is the compressor station and A, B, C, three outlets consuming 200, 50 and 350 cu. ft. respectively. The maximum permissible drop of 1.5 psi should be distributed as evenly as possible between the compressor and each point of utilization. In this example, the pressure drop in the valves, pipe bends, etc., is not considered.

SECTION K-D

Pipe length (L) — 150 ft.

Air flow (Q) — 600 cfm.

Working pressure (p) — 100 psi.

If the inner pipe diameter is assumed to be 3 in., a pressure drop of 0.5 psi is obtained.

SECTION D-A

Pipe length (L) — 300 ft.

Air flow (Q) — 200 cfm.

Working pressure (p) — 100 psi.

The pressure drop must not exceed 1.5 psi, reduced by the pressure drop in section K-D, 1.5-0.5, or 1 psi.

If the pipe diameter is assumed to be 2 in., the pressure drop will be 1 psi and the total pressure drop between K and A 1.5 psi.

SECTION D-E

Pipe length (L) — 200 ft.

Air flow (Q) — 400 cfm.

Working pressure (p) — 100 psi.

The size of pipe should be chosen so that the pressure drop will not exceed 0.8 psi. A diameter of 2.5 gives a pressure drop of 0.75 psi.

SECTION E-B

Pipe length (L) — 100 ft.

Air flow (Q) — 50 cfm.

Working pressure (p) — 100 psi.

The pressure drop must not exceed 1.5 psi reduced by the pressure drop between K and E, 1.5 — (0.5 + 0.75), or 0.25 psi.

A suitable pipe diameter is 1.25 in. which gives a pressure drop of 0.25 psi. The total pressure drop between K and B will then be 1.5 psi.

SECTION E-C

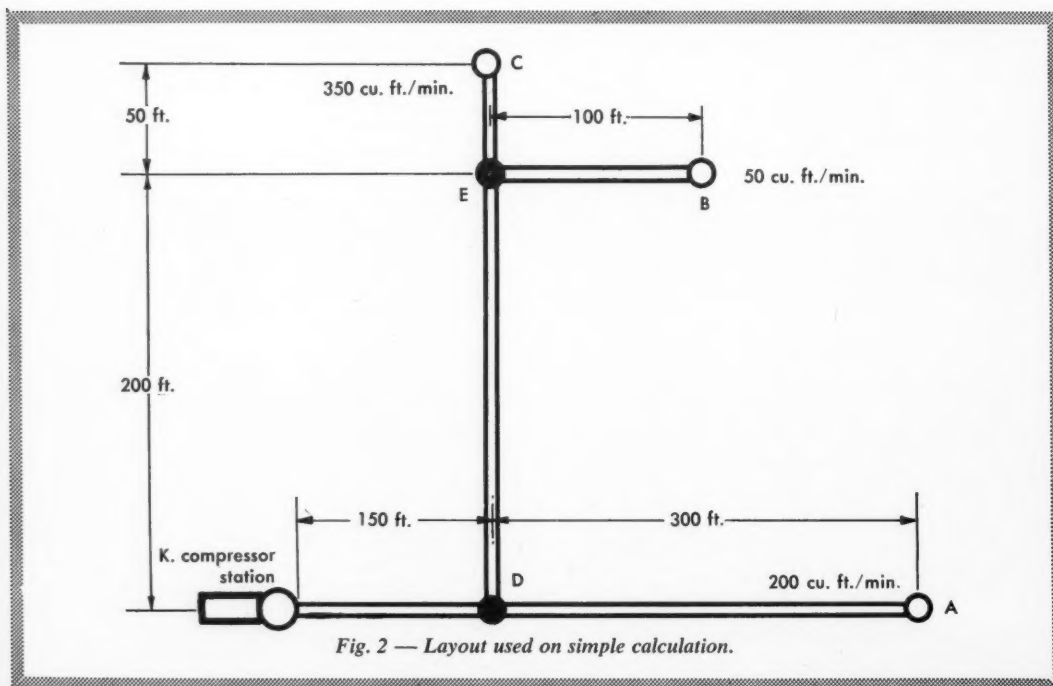
Pipe length (L) — 50 ft.

Air flow (Q) — 350 cfm.

Working pressure (p) — 100 psi.

The pressure drop must not exceed 0.25 psi.

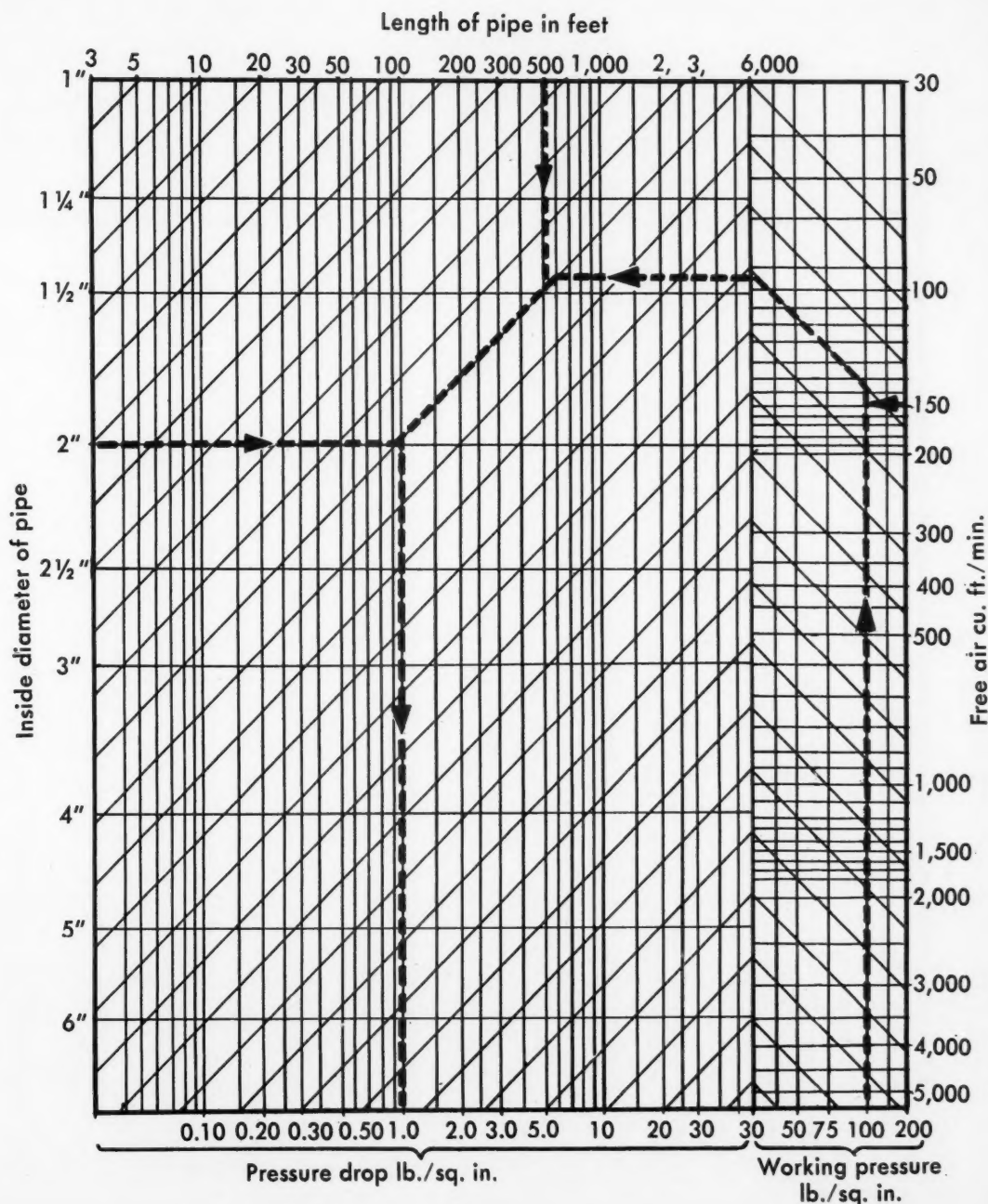
A suitable pipe diameter is 2.5 in. which gives a pressure drop of 0.16 psi and a total pressure drop between K and C of 1.4 psi.



Design Engineering

DATA SHEET

Pipe size nomograph





A champ of a boat—and all-Canadian

Eric Haworth *Assistant Editor*

One of the happiest fellows we've met in a long time was at the Canadian National Exhibition, a few weeks ago. His name: James Gordon (Jim) Thompson. His occupation: champion boat designer.

Thompson had something to be happy about. His boat, Miss Supertest III, had just won the Harmsworth Trophy — the world's premier powerboat racing award.

The sleek, 31-ft craft had streaked across the finishing line to capture the trophy for Canada for the first time since 1920. Bob Hayward, the boat's pilot, told DE that "In the straightaways the craft hit well in excess of 160 mph — holding onto the reins."

With a 12-ft 6-in. beam, Miss Supertest III looks right from every angle. Thompson took us over the boat and pointed out several design changes from the previous craft he had designed — Miss Supertest II (see Dec. 1955 issue of DE).

Principally, these are in the gearbox, supercharger, and other vital parts. The new boat is slightly smaller and lighter than her predecessor (6,000 lb as against 7,200 lb). When we questioned Thompson on the rating of the Rolls-Royce Griffon engine he said: "It's tagged at 2,000 hp — but you know what ratings are."

The massive power plant, and the supreme respect Thompson has for it, has much to do with the boat's success. But the "hidden" features are what has made it a world-beater. These include the use of laminated oak frames, magnesium underskin, aluminum sides and cherry plywood paneling on the top sides.

"I'm not just interested in out and out speed," said Thompson, "but I am concerned with building a first-class racing boat that will stand up to all the rigors of competition. We have a good boat but we're not just content with that. We are constantly experimenting on ways to improve it."

Many of Miss Supertest II's components have been used in the construction of the new craft — though Thompson says there are substantial design changes.

Jim Thompson's interest in speedboating got its first boost in 1952 when his father Colonel J. Gordon Thompson bought the former Miss Canada. The craft was re-named Miss Supertest. In 1954, Thompson produced Miss Supertest II, and with it, in November 1955, established new Canadian and British Empire records.

We asked 33-year-old Thompson (who is v-p of a petroleum corporation and a director of two other companies), how the new boat compared with the old Miss Canada. "Well, I think you could say that we've come a long way since then." Canadians seem to think so too. We questioned several CNE visitors what they thought about the boat's success. One man's opinion summed it up: "It's just about captured the imagination of Canadians everywhere." ★



Jim Thompson at the wheel of his record-breaking boat.

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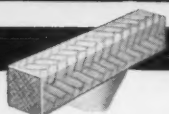
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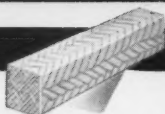
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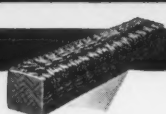
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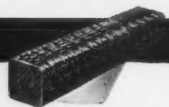
White asbestos yarn impregnated with Teflon†.



White asbestos yarn externally lubricated with Teflon.



Teflon multi-filament yarn, no lubricant.



Teflon multi-filament yarn lubricated with Fluorolube.



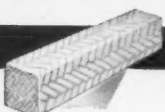
Teflon multi-filament yarn lubricated with Teflon.



Shredded Teflon encased in cotton jacket.



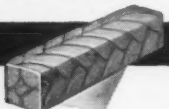
Shredded Teflon encased in Teflon tape jacket.



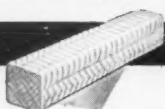
AAAA asbestos yarn lubricated with Teflon.



Crocidolite blue asbestos yarn surface-lubricated with Teflon.



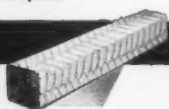
Crocidolite blue asbestos yarn lubricated throughout with Teflon.



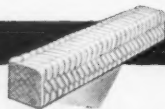
Teflon tape, no lubricant.



Teflon tape impregnated with chemically resistant lubricant.



Teflon tape jacket over crocidolite blue asbestos impregnated with chemically resistant lubricant.



Teflon tape impregnated with lubricant suitable for nitrating acid service.



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Keeping informed

New booklets and technical data for you to read

RTV Silicone rubber — bulletin CDS-191 tells the story about new rubber mold material for producing inexpensive epoxy resin models for tools, prototype models, fixtures. Canadian General Electric Co.

Valves, baffles, traps — altogether 28 pages of technical information very well put together on high vacuum applications. Consolidated Electrodynamics.

Copper based alloys—a wall chart shows complete data on composition and physical and mechanical properties of copper, bronze and brass alloys. Bridgeport Brass Co.

Brushless generator — want to know more about this high-speed unit? It's described in bulletin 51B9192 published by Allis-Chalmers Manufacturing Co.

Expandable polystyrene — Koppers Co. (plastic division) say their Dylite is the best insulating material for refrigeration and air-conditioning equipment. This booklet will help you make up your own mind.

Dielectric Materials — their properties at microwave frequencies are shown in a colorful chart. Emerson and Cuming.

Liquid metering — for barge loading, custody transfer, pipeline control and other uses a new Turbo-meter by the Rockwell Manufacturing Co. Plenty of information in this booklet.

Precision control—an eight-page booklet describes, in detail, all the features of strainers, regulators, flow controls and quick exhaust valves. Airmatic Valve.

Servo Components — if you're a facts and figures man, this brochure on control and torque synchros and resolvers, should interest you. Published by Vernitron Corp.

Spectrum analyzers — a meaty digest put out by Panoramic Radio Products gives the sort of information you'd expect in a folder on frequency calibrations.

Trigistor circuits — this bulletin is really application and circuit design notes of a survey of some basic trigistor circuits. Solid State Products publish it. ★

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With a specified wall thickness of only 0.005 inch, ± 0.002 , — 0.002 inch, a dimension approximately twice that of a human hair — the tiny zinc socket adapters shown in Fig. 1 incorporate probably the thinnest major cross-section ever die cast. Fabricated in volume lots by Gries Reproducer Corporation, the adapter is part of the Burndy Hyfen connector, used to provide a low-cost method for establishing reliable electrical connections.

Developed to speed the wiring of electrical harnesses and systems, this and other pin and socket-type assemblies are widely used with complex missile and computer circuitry to provide highly reliable electrical connections. Because these parts, generally, must be extremely small and produced to close tolerance and in intricate shapes, the design flexibility afforded by automatic precision die casting techniques has been applied extensively to turning out many current contact designs.

The Burndy Hyfen method, a recent innnovation, employs sets of pins which mate with collet-like sockets. To provide the expansion needed to accommodate the pin, the sockets utilize prongs which form an opening slightly smaller than the diameter of the pin. On insertion, the spring action of the prongs assures a suitable low resistance electrical connection.

Originally, Hyfen connectors were used without the tiny zinc die cast part which encircles the receptacle end of the connector. This cylindrical adapter socket or "cup for a closed entry socket" was added to the assembly, at the position indicated by the scribe point in Fig. 1, to improve performance of the unit.

Occasionally, upon insertion, a misaligned pin would catch on the end of one of the prongs, deforming it and affecting the contact adversely. To obviate this problem, the die cast adapter socket was developed. Critically dimensioned, it fits closely over the socket and prevents the prongs from deforming outward under the pressure of the male pin. In the section ahead of the prongs, the inner diameter of the adapter is reduced to the diameter

Dimensional uniformity

Tiny socket adaptors the die-casting way

Probably the thinnest major cross-section ever die-cast, these zinc adaptors were developed to speed the wiring of electrical harnesses

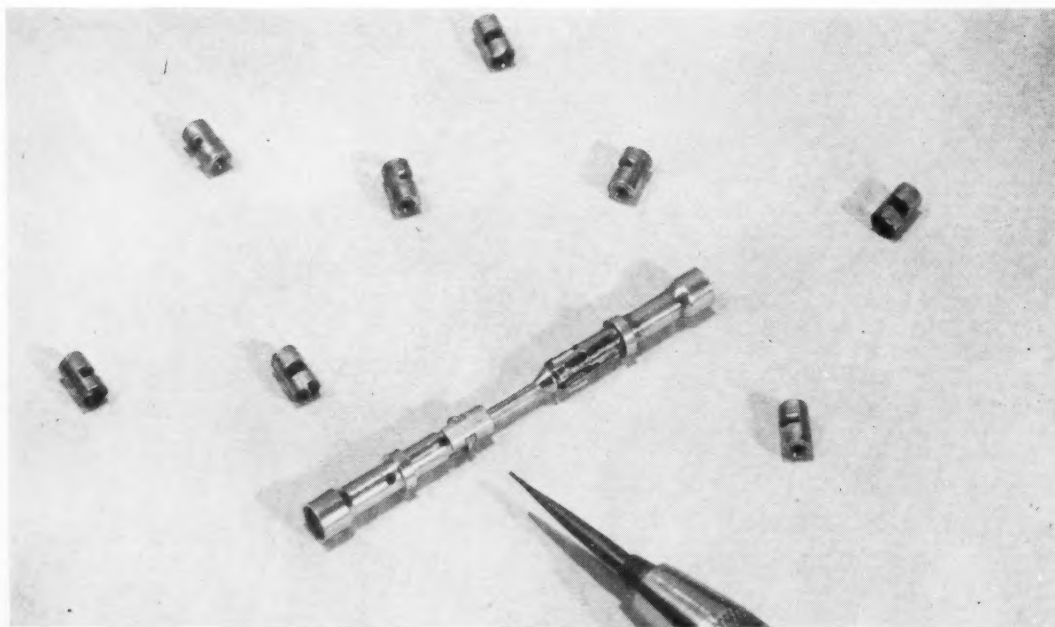


Fig 1—Close-up of tiny adapters. Wall thickness of smallest is 0.005-in., probably thinnest section ever die-cast.

of the pin so that the pin is guided into exactly the proper position. Two "windows" in the cylindrical part allow hooked ears of the prongs to protrude, locking the adapter firmly in position.

Three sizes of the adapter, gold plated for corrosion resistance, are used with correspondingly sized connectors. The smallest is 0.098 inch in diameter, has a length of 0.169 inch and weighs approximately 10,500 to a pound. Although limited in weight and size, parts require high strength and rigidity. Space limitations also posed unusual requirements since, in addition to close tolerances and uniformity of parts, complete freedom from burrs is also essential.

These minute parts could not be produced in quantity to such precise tolerances and at such low cost by any method other than the automatic die casting technique. Unique, fully automated equipment eliminates secondary operations and produces a completed part with each casting cycle. This means that casting, trimming and chamfering operations are performed on the machine as part of each split-second casting cycle, eliminating separate handling of parts and enabling dramatically reduced costs. Another prime advantage of the process is the single-cavity technique used exclusively with Gries' die casting machines. Dimensional uniformity is assured from part-to-part since all die castings are formed in the same cavity.

Other factors which contributed to the selection of die casting are the complex shape, variations in wall thickness and the absence of burrs required for efficient part performance. The most stringent requirement, however, is the 0.005 inch, ± 0.002 , — 0.002 inch wall thickness specified for the smallest adapter. This restrictive dimension causes this part to have probably the thinnest major cross-section ever die cast, and in conjunction with the intricate shape required, would preclude production by metalworking methods such as screw machining or stamping.

The socket cups were, in fact, made at one time from deep drawn steel. Burrs left after milling the slot aper-

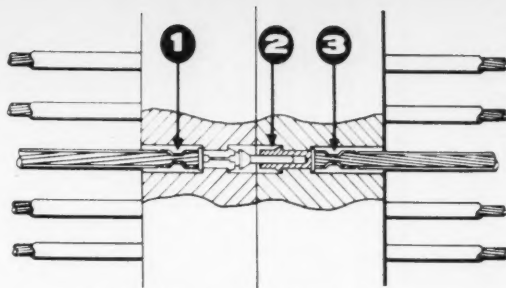


Fig 3—For high reliability, only three points of contact.

tures in opposite sides of the cups, however, had to be lapped out. In addition, tolerances and uniformity could not be maintained consistently, cost was high and weight of the parts excessive. By contrast, the socket cups now die cast weigh 20% less than steel, and are produced to exact tolerances with clean, burr-free edges.

The flexibility afforded by the Burndy method for making multiple electrical contact is emphasized by the many variations now in use. The rack and panel Hyfen connector (Fig. 3), for example, utilizes an interlocking one-piece shell and one-piece rack with 8- or 26-place configuration.

To establish highest reliability, these connectors employ only three points of contact — the minimum number — as shown in Fig. 2. Two of these connections — the joining of wires to the pin and socket — are accomplished quickly and effectively by pneumatic or precision hand crimping operations. Costly soldering operations and the disadvantages encountered with soldered joints are eliminated. The pins and sockets can be easily snap-locked into plugs and receptacles. When circuit changes or equipment checks are required, a simple extraction tool enables easy disassembly. ★

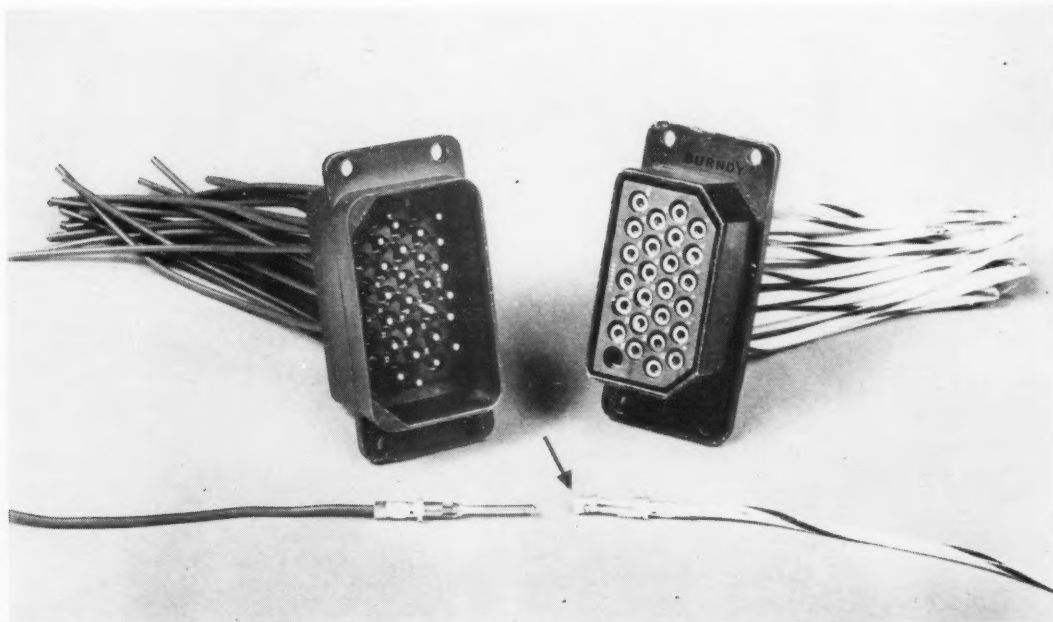
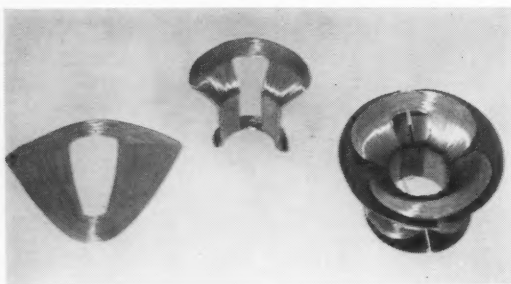


Fig 2—Connectors assembled in ME rack and panel. Small zinc adapter (arrow) prevents damage to part of assembly.

Ideas round-up

Magnet wire: more versatility



Magnet wire is becoming more and more versatile every day as new varieties are added to the presently available types. Among the latest are two varieties sold under the trade names of Isobond and Nythane.

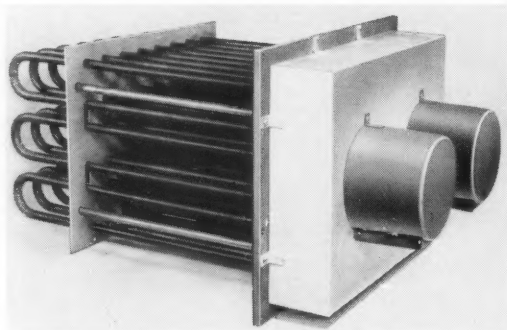
Isobond is a bondable film over polyurethane enamel. Its main features are its solderability at low temperatures and a high cut-through temperature. Principal use of Isobond magnet wire would be in the manufacture of form wound yoke coils.

Nythane magnet wire is a nylon coating over a polyurethane enamel. Its high solderability, abrasion resistance, chemical resistance and good windability make it highly desirable for use in series armatures and fields, stators and other difficult winding operations. It is especially suited for use on automatic coil winders. Nythane magnet wire is rated as a Class "A" magnet wire and is available in natural or red colored finishes. *Source: Federal Wire & Cable Company Limited.* (208)

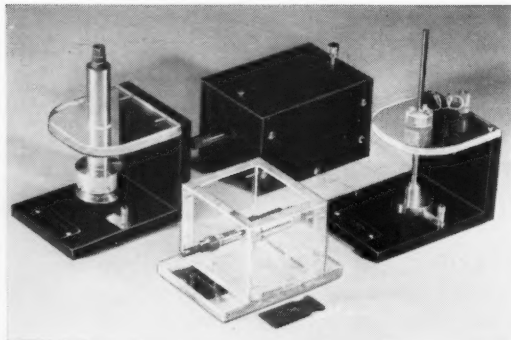
Forced air duct heaters (Type TDH) are designed for use in high-temperature air ducts and ovens for core drying, heat treating and annealing ovens, recirculating air ducts and similar applications. They are quickly and easily installed for trouble-free electric heat, and are recommended for air-heating applications where the operating temperature may be as high as 1050 F. For air velocities up to six feet per second, the air temperature should be limited to a maximum of 750 F. For air velocities greater than six feet per second the air temperature should be limited to a maximum of 1050 F.

Type TDH heaters employ Chromalox alloy sheathed tubular elements, mounted in a steel flange complete with mounting holes. Wiring terminals located outside the heat zone, may be connected so that the entire heater, or various sections, are separately controlled. All terminals and connections are of alloy construction and are enclosed in a steel housing. Individual heating elements are easily replaced. *Source: Canadian Chromalox Company Limited* (209)

High temperature heaters



Electrodes for testing



Electrodes for the high voltage testing of a wide variety of materials to ASTM specifications are now made in Canada. Jigs are available for testing dielectric strength or breakdown on electrical tapes, plastic sheets, insulating oils, pitches, and compounds and for testing arc resistance. Precision fabricated from carefully selected materials, these ASTM electrodes may be used with high voltage testing equipment made by Canadian Research Institute or by other instrument makers.

Illustrated is a group of plastic electrodes to fit exactly the requirements of American Society of Testing Materials Specification D-149-55T and accommodates all commonly used insulating materials. *Source: Canadian Research Institute.* (210)

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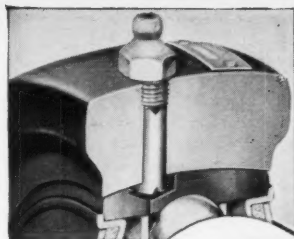
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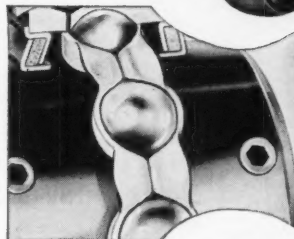
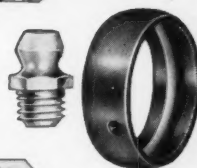
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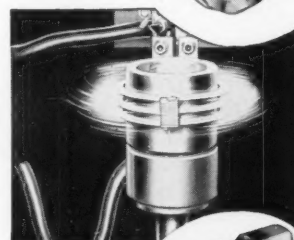
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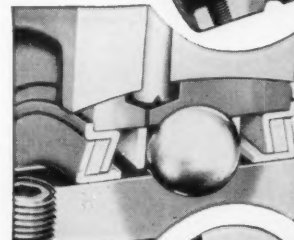
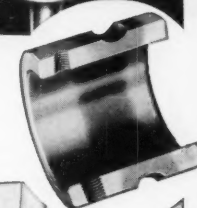
LOCKING PIN
AND PERIMETER
DIMPLE



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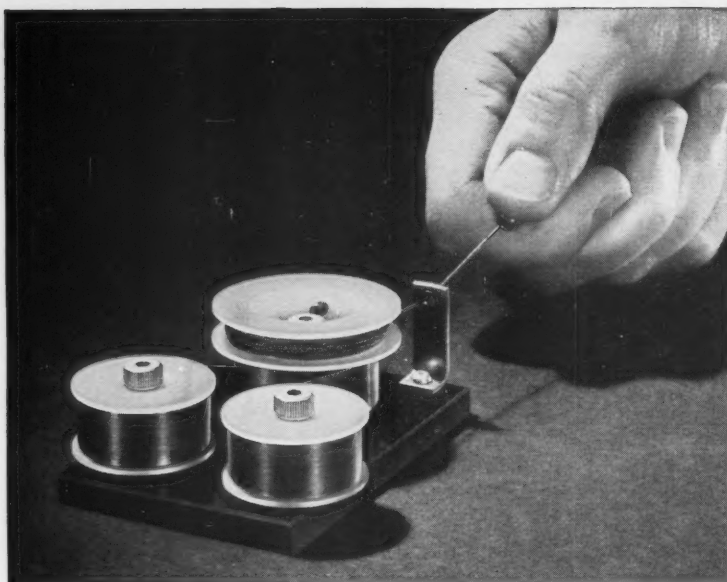


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NEG'ATOR® MOTORS FROM STOCK for Experimental Designers

As a time-and-cost saving shortcut for design engineers who need a means for applying constant tension forces through long deflections, Hunter now offers six stocked models of constant-torque NEG'ATOR Spring Motors.

Originally developed for use as "idea tools" for experimental design, standard NEG'ATOR Motors have found wide application as product components. For this reason, models carried in stock have been expanded to provide cable-tension ranges from 0.375 lb. through 5.0 lbs., as indicated by the table below.

Orders for stock motors will be shipped immediately. Prices are shown in the table.*

Model No.	Spring Torque in Lb.-In.	Cable Tension in Lbs.	No. Revolutions	Cable Length in In.	Endurance (Min. No. Cycles)	Price
P7172	.1	0.375	20	36	3,000	\$5.00
A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

P7172 MATERIALS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—aluminum; Cable—Nylon.

MATERIALS, OTHER MODELS: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—Black Plastic; Cable—stainless steel, preformed.

*Prices shown are not indicative of the cost of NEG'ATOR Springs when made in quantity, to specifications, for large-volume motor and other applications.



For a good idea on how NEG'ATOR Springs are being applied, ask for Issue 12 of the NEG'ATOR SKETCHBOOK.



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Briefs

We note with interest . . .

that flashlights are in the news. A company in New York state is mass-producing a rechargeable battery; another has leakproof steel outer jacket plus internal chemical chrome coating . . . **Canadian developed** electromagnetometer which dangles below a helicopter in flight, is now in use in prospecting for mineral deposits . . . **one paint company's** industrial finishing system gives manufacturers a choice of over 1,300 colors (including metallics and hammertones) . . . **we read** of a form of fiberglass being made up into decorative panels which can be wall or floor mounted, and used as a domestic heating material . . . **the tunnel diode** (first cousin to the transistor) is a year old and could lead to revolutionary changes in the electronics industry . . . **in Cambridge, England** a remarkable cell which makes electricity by reversing the chemical process of storage batteries was demonstrated recently. The inventor has been working on the project for 25 years . . . **talk about** getting pampered — a new hair dryer is equipped with a hi-fi speaker built into the hood. Madam flicks a switch gets canned Como with her waves . . . **after five years** of research a Canadian company has discovered a new system of bonding polyester fiber to rubber, we are told . . . **two Toronto men** have invented an explosion-proof gas tank . . . **a steel company** in the U. S. has spent \$33 million on a new method (and facilities) for making steel . . . **Clifford Pridgeon** a former Calgarian has invented a bale stacker on his Montana ranch that has been described as the greatest time and labor-saving addition to haying equipment since the baler . . . **we were surprised** to learn that the food and beverage industry is by far the largest manufacturing group in Canada. It accounts for about one fifth of the value of all goods produced . . . **news comes** to us about a caulking compound based on chlorosulfonated polyethylene: if that won't cold shoulder a cheeky east wind, we don't know what will . . . if the exploits of World War I form part of your interest, there's a book just published called "Air Aces of the 1914-1918 War": it contains the biographies of 135 of the world's aces and lists 1,500 names of "Ace" status . . . **fabrication** of an atomic reactor for the Walter Reed Army Medical Center in Washington, has begun. Unit will use uranyl sulfate in solution as fuel . . . **a young German**

(Continued on page 73)

Briefs *Continued from page 72*

design-engineer working in Calgary has evolved a machine that pre-fabricates doors in 2½ minutes . . . **Pakistan's first** newsprint mill was designed, built and put into production by a B.C. firm . . . **and from Ottawa** comes news that work will be undertaken this fall to increase the potential capacity of the Welland Canal by about 25% . . . **cost-cutting** on the machines that total your costs: release tells us that a certain line of adding machines sells for \$100 under machines of comparable quality. They say the secret is a fully automated factory which turns the mechanical misers out one every two minutes . . . **Du Pont** of Canada have moved into their new research laboratory near Maitland in the Brockville, Ont., district. The two-story building has five labs . . . **progress has a price.** The modern version of the Olympic torch utilizes flashlight batteries which trigger a lighting mechanism for igniting the flame . . . **Dates for your deskpad:** October 1-3 in Toronto—Canada's Power Show; October 5-9 in Los Angeles — Society of Automotive Engineers meeting features engineering details of missiles, space ships and planes; October 12-14 in Chicago — 15th Annual Electronics Conference; October 22-23 in Minneapolis—American Marketing Association's Seventh Biennial Marketing Institute . . . **the Holley Medal** bestowed for an act of engineering resulting in public benefit will be awarded to Col. Maurice J. Fletcher for designing artificial limbs credited with giving amputees a new freedom of movement . . . **Calgary's in the news** this month — from there comes a clip telling us about the new type drilling rig that can be moved from site to site in a matter of minutes . . . **a Toronto company** has started a plastisol dip and spray coating service — and frankly looks forward to doing a thriving business . . . **don't panic** — but they're building electric autos again. A low-slung sports car job is made in San Diego; is powered by four batteries and has top speed of 58 mph. In Cleveland, O., plans are being made to produce an electric car using the Rambler American body on a 110-in. wheelbase . . . **newly formed company** specializing in the design and manufacture of fluid power transmissions is the Richardson Equipment Co., of Highland Creek . . . **a manufacturer** of a tool for precision cutting of control and switch shafts got a testimonial from an unexpected source a few weeks back. Tool was described in the Matilde Zeigler Magazine — and aroused considerable reader interest. Company thought this was unique as the book is published in braille . . . **Man with an unusual hobby** is Edward Kaju of Toronto. He has just finished

building himself a submarine: studies the underwater life in Lake Simcoe . . . **Brief Talepiece:** Hear about the Rip van Winkle Rolls Royce? In 1911 a Danish baron bought a RR. After 20 years he decided to sell it, but couldn't get his price. Picqued, he had the car walled up in the castle. Then nearly 30 years later, the baron's heir was told about the incident. Searchers finally broke through a brick wall and found the old girl — then a bit cobwebby around the wipers. You can guess the rest. After a new set of tires and a new battery the car is purring along as good as new. ★

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New products & materials

Transformer Indicator

Accurate large scale indication and recording of linear motion, size, weight, force, pressure and all other quantities measurable by differential transformer transducers is achieved with the new Daytonric Corporation Model 300 A Differential Transformer Indicator.

Completely self-contained, the instrument features a 10 in. Weston panel meter, a constant current excitation supply, self-checking features which

eliminate drift errors and five calibrated sensitivity ranges which cover all usual scientific and industrial requirements. Accuracy is 1% with maximum resolution of .000005 in. of core displacement.

Special dial markings are available as required. A suitable electrical output is provided for direct operation of standard potentiometer recorders.

Further details on specifications, or assistance on application of this device is available from the Electronics Division,



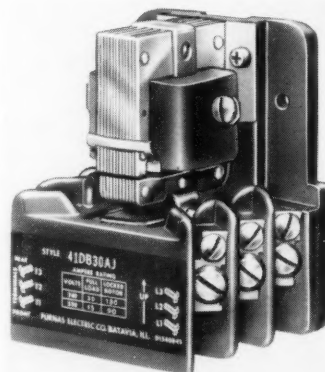
A. C. Wickman Ltd.

(219)

Magnetic Controls

The new Furnas Electric Class 41 contactor line rated in 20, 30 and 40 ampere sizes for air conditioning and refrigeration are also rated through 10 hp, 230 volts and 15 hp, 575 volts poly-phase for across-the-line control of electric motors, heating and lighting loads.

One-piece molded frame and arc box provides a self-insulating base which is highly resistant to tracking and moisture. Solenoid assembly is silicon steel and sealing surfaces are precision ground to provide positive quiet operation at all times. Molded magnet coils are moisture resistant. These coils are also available



with screw type terminals, quick connect terminals or with wire leads from Davis Automatic Controls Ltd. (220)

Thermoplastic extrusions

Extrusions and fabricated parts made from Du Pont's new thermoplastic, "Delrin", are now available.

Extrusions are in the form of strip, rod, tubing, or special shapes. Strip comes in widths up to seven inches and thicknesses from 0.020 in. to 0.093 in. Rod diameters range from 1/2 in. to 2 in. Tubing and special shapes are made to order. From these basic extruded forms, the company can produce a variety of precision parts, employing conventional machining operations. National Fibre Co. (221)

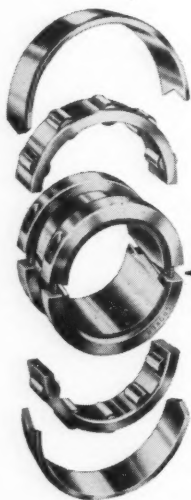
Locking adapter

A locking adapter has been developed to bring users of electronic instruments,

Continued on page 79

SAVE "DOWN TIME" WITH

COOPER *split* ROLLER BEARINGS



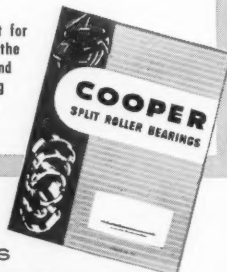
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down
to the
shaft

Cooper Split Roller Bearings have all the advantages of conventional roller bearings, PLUS being SPLIT—right down to the shaft! For mounting, Cooper bearings are assembled around the shaft—not pushed or pressed on the shaft. They may be mounted where it is impractical or impossible to mount conventional solid race bearings.

The unique SPLIT feature saves "down time", money, and space. With Cooper bearings you get all the advantages of regular roller bearings with a Big PLUS!

Superb construction, high load-carrying capacity, and long life make Cooper Split Roller Bearings the first choice with designers and maintenance engineers.

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- ★ HIGH TEMPERATURE INSULATION



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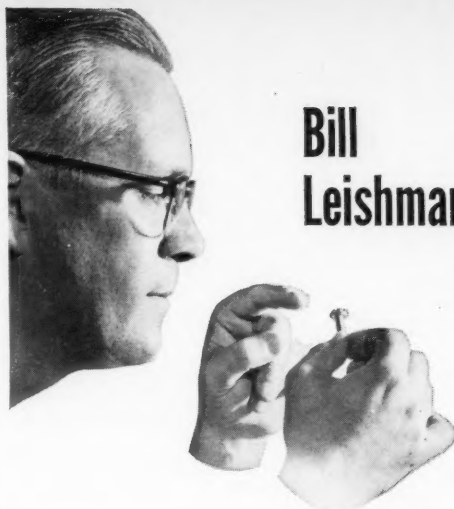
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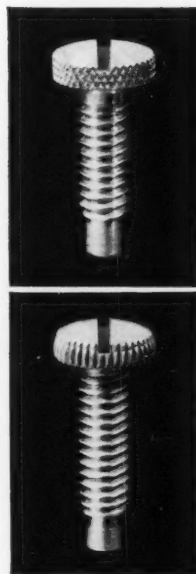
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*Mr. L. W. Leishman represents Stelco in the Niagara Peninsula. He is one of a group of representatives specially trained to bring personal interest and expert attention to your needs in Special Fasteners.

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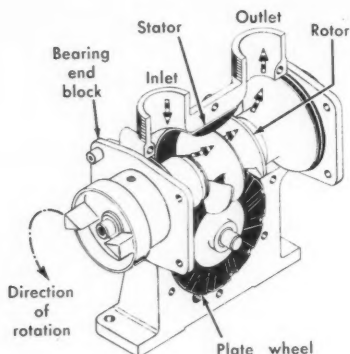
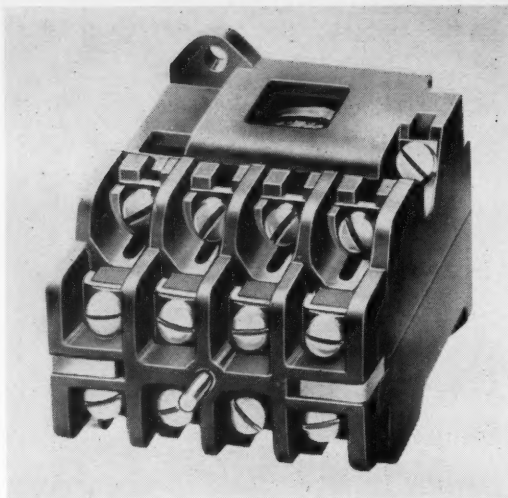
59381.C

Universal magnetic relay

For easy wiring, all terminal screws are accessible from the front of this compact universal magnetic relay.

The magnet and movable contacts operate horizontally to produce an improved contact performance and the unique design provides for up to eight easy to get at, independent contacts on a base of only 2 in. x 2 in.

The relay is of genuine contactor design, providing heavy-duty, double-break, silver-to-silver contacts with separate feeds on every contact arrangement. Since it is HP rated too, the relay can be used for single-phase and three-phase motor control, as well as for remote control lighting and heating circuits. *Source: Klockner-Moeller Canada Ltd.* (211)



In early 1958, a new all-purpose industrial pump made its debut in Britain. According to reports, this positive-displacement unit was very well received; it is now being

Positive-displacement pump

offered to Canadian industry.

Inherently self-priming, the pump provides suction lifts up to 30 ft. at speeds between 750 and 3,000 rpm. Capacity is claimed to be constant at any given speed against pressures from 0 to 100 psi.

Only two moving parts contact the liquid—the metal rotor and a rubber-bonded plate wheel. Motion of the screw-type rotor between the plate wheel and a rubber stator forms an advancing cavity that assures positive liquid displacement.

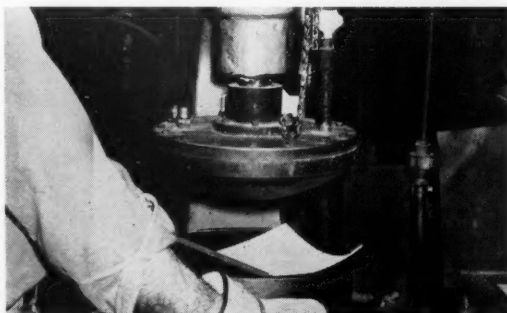
Characteristics include positive axial flow, pulseless action and high efficiency. Permutations of the four body materials, three rotor materials and four elastomers can satisfy a major portion of possible applications. *Source: Holman Brothers (Canada) Limited.* (212)

Water-cooled die saves time

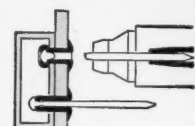
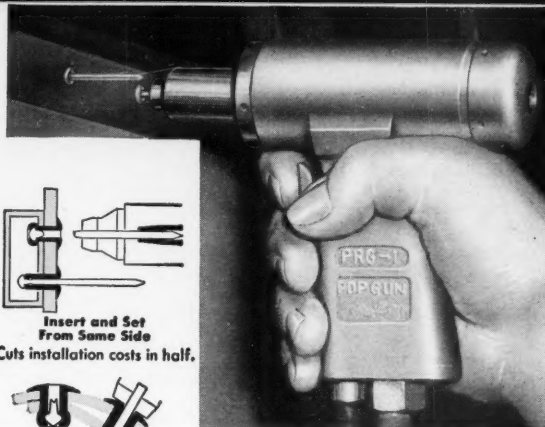
Water-cooling of the forming dies is claimed to save time in postforming certain laminated plastic parts. This eliminates the need for separate time-consuming cooling of parts on special fixtures after the forming operation. The temperature of the part shown in the photograph, for example, is lowered to the point where it will take a permanent set in one minute by use of the water-cooled die. Air-cooling in a fixture would require approximately five minutes, and a special fixture would be needed to prevent uncurling of the part while cooling.

Practicability of using water-cooled dies depends upon whether: (1) the production run is long enough—10,000 parts and up—to justify the about-double cost of the die; (2) complex curves would otherwise require the molding of special fixtures to prevent the part's uncurling during cooling, or, (3) use of cooling fixtures

would take up too much valuable room or slow the over-all postforming production cycle. Slow-cooling takes three to four times the combined heating-and-forming time. *Source: Taylor Fibre Company.* (213)



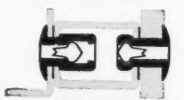
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Insert and Set From Same Side
Cuts installation costs in half.



High Clinching Action
Pulls parts together with up to 600 lbs. squeeze. Eliminates need to clamp.



Wide Grip Range
Simplifies inventory, purchasing, inspection. Same length "POP" Rivet holds tight through thick or thin.



Vibration Proof
"POP" Rivets cannot back out or become loose. Ensures tight assembly for years of use.



Low Head Profile
Where space is important, "POP" Rivets' minimum head height eliminates clearance problems and improves appearance.

Cut Assembly Costs
Solve Design Problems
Installed and set from same side

"POP" Rivets cut installed fastener costs, add design flexibility, and increase assembly convenience because they are inserted and set from the same side. Up to 1200 can be set per hour right on the assembly line — even by an unskilled operator.

"POP" Rivets are precision made, hollow rivets assembled on a solid high tensile mandrel. The setting tool pulls the mandrel head into the rivet from the front side, setting the rivet on the reverse side. Mandrel breaks under tension of up to 1600 lbs. and falls free.

You can cut installed costs, increase assembly convenience, and secure high speed, trouble-free fastening immediately with "POP" Rivets. No need for complicated or extensive re-tooling. Simplify product design, cut handling time. Call or write us today — now — and start cutting your installed fastener costs with "POP" Rivets! Or better still, send us a sample assembly for riveting.



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Any Speed from zero to $\frac{1}{4}$ input speed (max 2000 rpm)

Change Speed instantly — running or not

Reverse Speed instantly — running or not

Zero-Max Speed Reducers are available in many models from $\frac{1}{30}$ th to $\frac{3}{4}$ hp with or without motor and with or without reverse. The standard series has speed ranges from zero to 400 rpm with torques up to 100 in. lb. Models with speed-increase and speed-decrease gearheads have speed ranges from zero rpm to the motor speed (max 2000 rpm) with torques up to 450 in. lb.

Stops, starts, speed changes and reversal of direction are made instantly, merely by moving a lever* and without stopping the machine. Every ZERO-MAX gives positive drive with constant torque throughout its speed range. ZERO-MAX has a wide range of models for use in machine tools, metal working, materials handling, packaging, processing, office equipment, etc.

For further information on the versatile ZERO-MAX, call your nearest RENOLD office.

*Other optional controls available.

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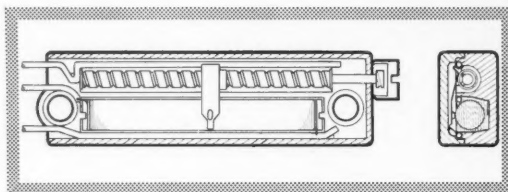
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High accuracy promised with trimmer potentiometer

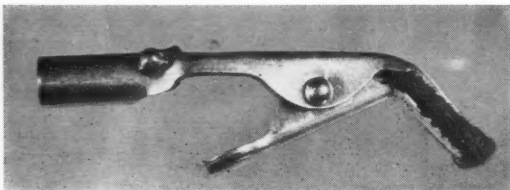
A miniature trimmer potentiometer with high accuracy and dependability has been developed. One of its features is its accuracy; when once set, it remains at ohm setting under a wide range of environmental conditions.

Eleven outstanding features of this W-10 potentiometer are: (1) All-welded internal connections; (2) welded connections and winding potted in high-temperature epoxy. (3) Full-length terminals dissipate heat; (4) Double connection—rotating and sliding for positive contact with wiper; (5) Wiper arm made of precious metal, completely damped; (6) New ratchet design. No backlash at any point. Constant wiper pressure; (7) Stainless steel adjustment screw; (8) Kel-F insulator provides moisture and dust barrier; (9) U washers maintain

positive screw tension. Won't rotate and cause wear; (10) Interlocking case has high-temperature epoxy seal. Stainless steel eyelets; (11) Ratio of mass to interior space is 9 to 1 for extra strength. *Source: Atholm Electronics.* (214)



Novel "heat sink" prevents component damage



A simple, safe and effective method developed at Boeing for soldering heat-sensitive electronic components to circuit cards has resulted in a marked decrease in reject-

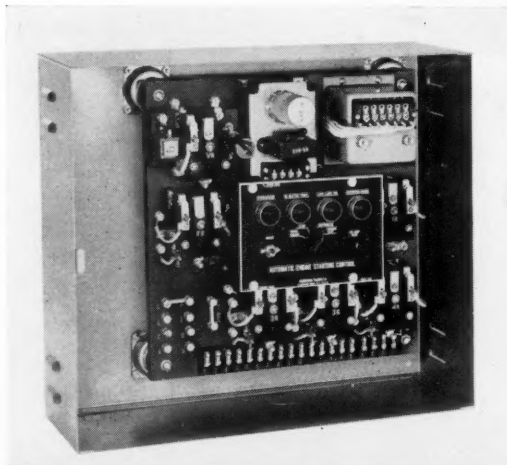
tions due to heat damage.

In soldering electronic components to circuit cards, heat is conducted along the lead wire from the soldered joint to the component. Unless some precautionary measure is taken, sensitive components can be damaged by the heat. To prevent such damage, a Boeing manufacturing research engineer developed a novel "heat sink" consisting of a standard metal clamp lined with felt. The felt is saturated with water and the clamp attached to the lead wire between the soldered joint and the component. Heat traveling along the lead wire is dissipated by evaporation of water from the felt, thus protecting the component. *Source: Boeing Airplane Company.* (215)

Automatic engine control

A new automatic engine starting control, intended for fully automatic starting and stopping of engine-driven generating sets is now available in Canada. This new equipment has the following principal features: (1) positively prevents recranking at full engine speed, (2) controls are designed to respond at 50% of normal battery voltage, (3) operates over broad ambient temperature range, (4) repeating or continuous cranking cycles provided by same panel, (5) industrial type components used throughout, (6) motor-driven timing device, (7) operates from single pole contact on automatic transfer panel or control station.

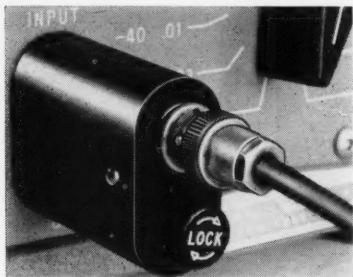
Modified arrangements can be obtained for two-stage starting, special cranking sequence, automatic circuit resetting after correction of abnormal conditions, and special enclosures. *Source: Davis Automatic Controls Limited.* (216)



New Products

Continued from page 74

the convenience and reliability of coaxial connectors to instruments equipped



with binding posts on standard 3/4-in. spacing.

Approximately one-half turn of the lock screw expands a plated steel banana pin within the binding post, securely locking the adapter in place.

Choice of the BNC and UHF Models provides flexibility in inter-connection of instruments used in test setups. Shielded models aid in reducing noise and hum. Unshielded models mate to three terminal binding post assemblies. The adapter is manufactured by the **Highland Electric Co.** (222)

Electronic voltmeter

A "pocket-sized" AC electronic voltmeter, designed for applications where space is extremely limited and sensitivity is not too important, has been developed by Metronix, Inc.

Model 332 is believed to be the smallest VTVM ever offered commercially. Panel-mounted, it uses a 2 1/2-inch meter and has a barrel only 2 inches in diameter and less than 4 3/4 in. long.

With a basic range of 0 to 100 millivolts r.m.s., unit is most suitable for applications of medium sensitivity where a straight AC voltmeter is ruled out because of its low input impedance. **Metronix, Inc.** (223)

Morval arc welders

New machines for manual arc welding are said to have improved arc characteristics and many new optional features that permit the manufacturer to supply machines "tailor-made" to customer needs at a price consistent with large volume production.

The welders, called the "TM," are available either as AC transformer welders or combination AC and DC rectifier welders. They have a mechanical, movable core reactor type of current control and are made in NEMA rated 300, 400, 500 and 650 ampere sizes.

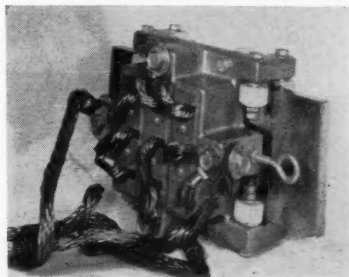
The machines have a safe 73 volt open circuit voltage, yet produce a very

stable arc even with low AC amperage and difficult-to-use electrodes.

Construction features provide added convenience and reduced maintenance. For example, a signal light indicates when the machine is turned on; the front panel is recessed to prevent accidental damage to controls; the current control is continuous and adjusts from maximum to minimum settings with only 27 turns. **Lincoln Electric Co.** (224)

Mobile Pick-up Trolley

Trolley type high-current pick-up device with capacity for handling up to 1200 amperes is basically designed for welding and plating systems. The Hi-Amp Pick-Up is also suitable for any high-current application. It is guided in all positions



by nylon rollers, which require no lubrication.

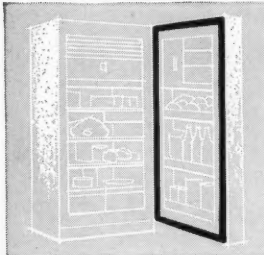
Continued on page 81

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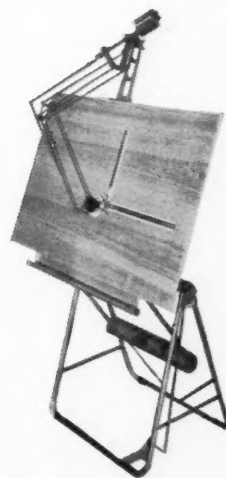
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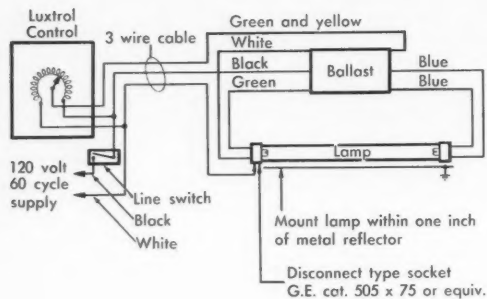
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Fluorescent dimming ballast



A fluorescent dimming ballast that permits smooth, flickerless control over a wide range of illumination, has been announced. Designed for use with Luxtrol light controls, it has a range of maximum illumination in a ratio of 500 to 1. For example, a fluorescent luminaire having an output of 1,000 lumens can be dimmed to two lumens.

All lights come on at the same time, and it is not necessary to bring them up to full intensity before setting the light control.

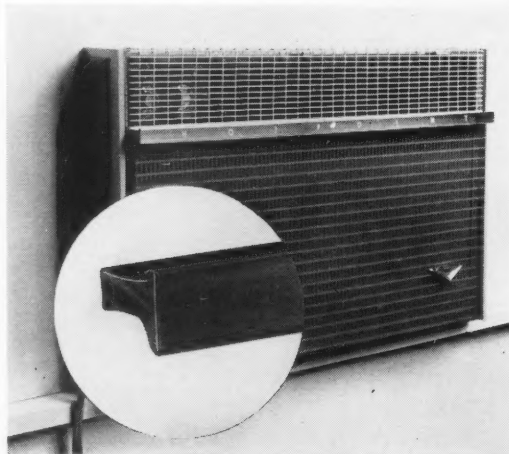
Flickerless starting at any intensity level within the control range is also made possible by the new ballast. Lighting set by Luxtrol at a desired level of illumination (before being turned off) may be turned on at the same level without adjusting the control. *Source: The Superior Electric Company.* (217)

Portable air conditioner

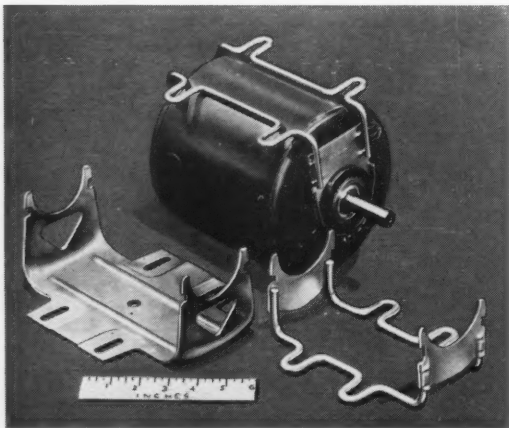
Modern styling of the new Hotpoint Power-Plus portable air conditioner is enhanced by a combination grille-handle, trim and nameplate made by extruding Tenite butyrate plastic over aluminum foil strips.

Transparent amber in color, the butyrate gives the foil strips—embedded about 1/32 of an inch below the top and front surfaces of the extrusion—the appearance of brass with the added advantage that they will not tarnish as brass does. A special bonding process eliminates wrinkling of the foil or separation of the foil from the plastic.

Resistant to the impact of repeated opening and closing of the grille, the butyrate extrusion gives sturdy service, yet adds little weight to the over-all unit. *Source: Eastman Chemical Products, Inc.* (218)



Wire mount aids design



This twin-arm wire motor mount permits reductions in shaft height of 1/4 in. or more over conventional stamping-type mounts, by allowing the base of the motor frame to nest between its two parallel base wires. This feature (combined with its lightness) is particularly suited to air-conditioning units, portable appliances, and other applications where over-all compactness is a major design objective.

Because of the natural resiliency and vibration-dampening characteristics of wire construction, the new mount also permits improved decibel ratings. The open configuration allows unrestricted air circulation, reduces air turbulence.

These twin-arm motor mounts are manufactured to NEMA specifications, and can support the motor horizontally or vertically. *Source: E. H. Tichener & Co.* (219)

New products

Continued from page 79

The roller mounting permits it to be applied to curved as well as straight bus bar sections. It can be used with either vertical or horizontal bus bars. Small amount of clearance only is required by the unit when in motion. **Anchor Steel and Conveyor Co.** (225)

New packaging for batteries

Clear plastic containers are replacing the molded hard rubber containers formerly used to house the largest types of communication and control batteries, we hear.

A rubber cover is sealed to the container to form a permanent leakproof unit. As an added feature, the cover has a lead insert bushing molded into it at the opening for the terminal or connector post. The post and the insert are welded together to form a positive, leakproof seal. **C&D Batteries, Inc.** (226)

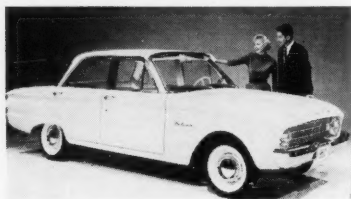
Extra light ball bearings

Hoover Ball and Bearing Company has announced the addition to its product line of a 3L00 extra light series ball bearing, featuring a wide selection of sizes and types.

Dimensions for width and outer diameter are substantially smaller than standard light, medium or heavy series bearings of comparable shaft sizes. As result, these extra light bearings are recommended for applications requiring maximum shaft diameters and minimum housing areas. (227) ★

New economy car

This is the Ford Motor Company's answer to the increasing demand for



economy cars.

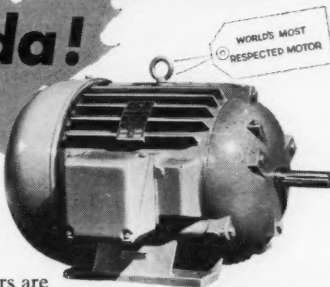
It's the Falcon — a six passenger, 90 hp model with a six cylinder front mounted engine. The vehicle has a 109-in. wheelbase, an overall length of 181 in. and a width of 70-in., plus unitized construction.

The last 90 hp engine made by Ford weighed 190 lb. more than the Falcon's. New power plant employs cast iron block, aluminum in flywheel housing, transmission extension, pistons and other parts, and this accounts for most of the saving.

The Falcon is said to average 32 miles per gallon. ★

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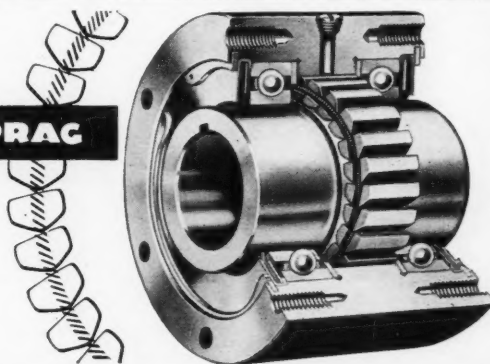
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simple in design and operation. There is a size and model Formsprag clutch for every application.

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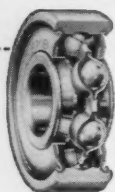
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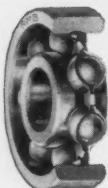


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Big bearing sealed performance in miniature sizes from 0.0550" Bore — 0.1875" OD. An RMB "first."

* Radial Conrad type.

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* Radial Ultra-Light.

Precision space savers. Combine large bores with relatively small OD's. Sizes from 0.0394" Bore — 0.1181" OD.

* Pivot type.

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RMB Miniature Bearings are described in this complete catalog which gives valuable information, too. Write for your copy today.

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People in the news

James Warren has been appointed Professor of Industrial Design at the National College of Art, Lahore, West Pakistan. When interviewed by DE, Warren said: "Initially, my tenure is for three years, and this will be taken up by establishing a design school. Two other schools are being formed, one for Art and the other for Architecture." Warren was previously head of the product development section of General Steel Wares, and one of the most active members of the Association of Canadian Industrial Designers.



Warren



Warden



Petersen

Recently appointed to the sales division of the International Nickel Company — **C. L. Warden**. He is a graduate in metallurgical engineering from University of Toronto.

Formerly senior sales representative for the company, **Eric Petersen** has been appointed manager, Ontario Division of Whitehouse Fastenings Ltd.

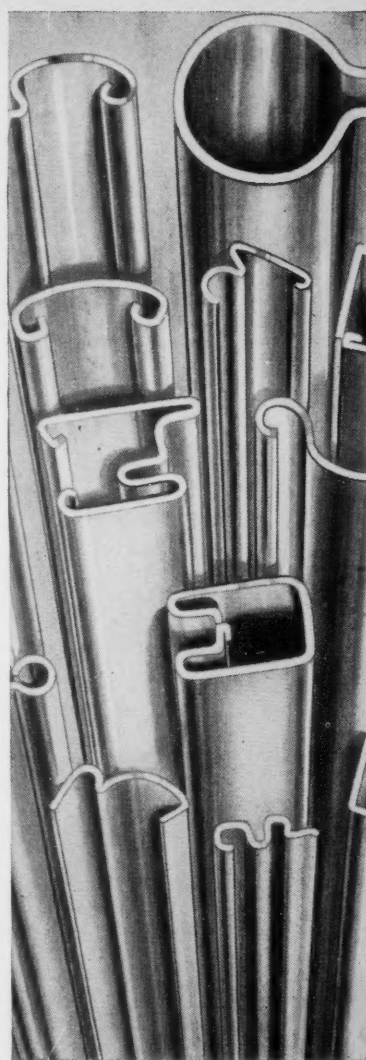
D. G. Willmot, B. W. Richardson and W. D. Sikrtanc were elected chairman, president and general sales manager, respectively of Powertronic Equipment Ltd, at a recent meeting.

Naugatuck Chemicals have appointed **Dr. Taylor Evans** to the position of manager, market research. Evans is a fellow of the Chemical Institute of Canada.

William J. Young has been appointed assistant director of public relations for The Steel Company of Canada.

There are now 18,500 professional engineers registered in Ontario. **Dr. George B. Langford**, chairman of the certification board of engineering and technologists, reported excellent progress in the certification program of the Association of Professional Engineers of Ontario.

Elected to a directorship of Haddin, Davis and Brown (Alberta) Ltd, consulting engineers — **Douglas Thierman**, manager of the firm's Edmonton office. ★



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PAGE 83-84 MISSING READER'S SERVICE CARD

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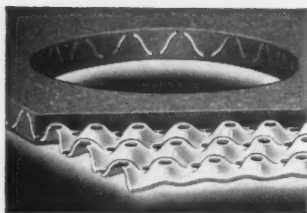
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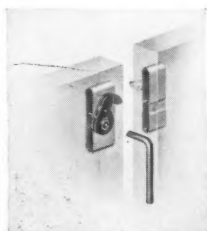
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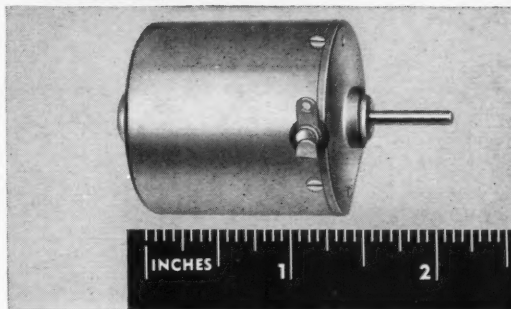
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Editorial

Engineering craftsmanship

Engineering is generally regarded as an exact science, but the experience of those who have been exposed to it for any length of time seems to indicate otherwise.

Engineering consists of applying the fundamentals of such pure sciences as physics and chemistry, with the aid of mathematics, toward the solution of a problem. Yet there is much more to good engineering than the mere mechanical application of scientific fundamentals and hypotheses; there is a high degree of craftsmanship involved.

If no craftsmanship were involved, no premium would exist on that valuable commodity called experience. There is no doubt that the seasoned engineer usually can show more masterful results than the new graduate, yet both have essentially the same training in the basic sciences, and both have access to the same sources of engineering references.

Craftsmanship in the engineering profession, or in any other profession, should not be glossed over lightly. Experience is a prerequisite for it, imagination helps to develop it, education fosters it, and intuition aids in knowing when and how to make use of it.

Craftsmanship is that quality of the engineer which is difficult to evaluate but which is readily discerned in his work. Craftsmanship and the other similar qualities are all closely interrelated, for the individual who displays any one of these traits to a strong degree usually is quite well endowed with the others.

Craftsmanship is a characteristic which is neither hereditary nor in-born. It is a quality which every engineer can develop within himself if he has the determination to do so.

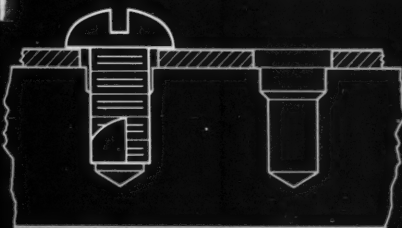
Perhaps, then, we may conclude that engineering is not truly an exact science. There is a great deal of art, or craftsmanship, required in its practice. The successful engineer is one who has developed in himself this indefinable craftsmanship.

Doug Kaill



HOW TO SELECT COST-SAVING

fasteners for plastic



A TYPICAL EXAMPLE: Cuts its own thread—

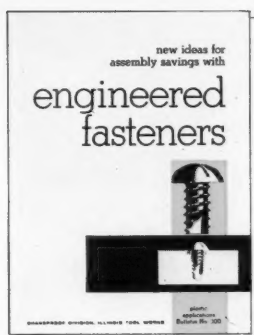
Shakeproof's® Type 25 Thread-cutting Screw saves time because it eliminates tapping. Blunt point assures maximum thread engagement and high holding strength when driven into a relatively thin panel.

Shakeproof has pioneered in developing ingenious, cost-cutting fasteners for plastic applications. The screw featured above not only taps its own hole—often it eliminates costly threaded inserts. Another Shakeproof development, the Type 17 self-drilling Nibscrow®, both drills and taps as it is driven. A Shakeproof Dished Lock Washer compensates for differential in expansion between plastic and metal . . . temperature changes won't loosen the assembly.

For highest quality fasteners that assure faster assembly and lower costs investigate the Shakeproof line. There's a Shakeproof fastener to meet your need—or Shakeproof engineers will develop one for your specific application.

WRITE FOR NEW SHAKEPROOF BULLETIN NO. 300

Shakeproof Bulletin 300 shows ten typical, profitable applications of Shakeproof fasteners on products using plastics. Offers free samples for testing. Send for your copy now.

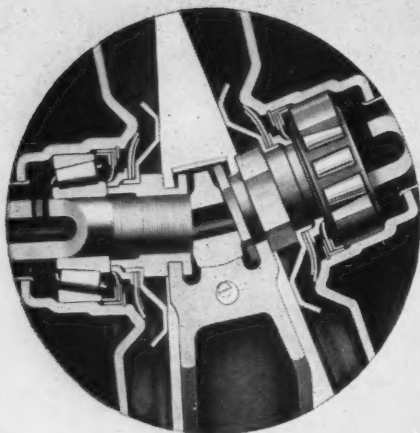


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